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NASJRB WILLOW GROVE  
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FINAL BASEWIDE RADIOLOGIC MANAGEMENT PLAN NAS WILLOW GROVE PA  
3/1/2014  
TETRA TECH



**Final**

## **Basewide Radiological Management Plan**

**Naval Air Station Joint Reserve Base  
Willow Grove  
Willow Grove, Pennsylvania**

**March 2014**

Prepared for:

**Department of the Navy  
Base Realignment and Closure  
Program Management Office Northeast  
Philadelphia, Pennsylvania**

Prepared by:

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Prepared under:

**Naval Facilities Engineering Command  
Contract Number: N62470-08-D-1001  
Task Order: WE42**

**FINAL**

**BASEWIDE RADIOLOGICAL MANAGEMENT PLAN**

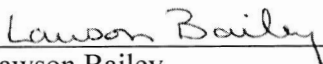
**NAVAL AIR STATION JOINT RESERVE BASE WILLOW GROVE**  
**WILLOW GROVE, PENNSYLVANIA**


**March 2014**

**Contract task Order WE42**

**Prepared for:**  
**Department of the Navy**  
**Base Realignment and Closure**  
**Program Management Office Northeast**  
**Philadelphia, Pennsylvania**

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## ABBREVIATIONS AND ACRONYMS

$\mu\text{R/hr}$	microroentgens per hour
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
BRAC	Base Realignment and Closure
$\text{cm}^2$	square centimeter
$\text{cm/s}$	centimeters per second
Co-60	Cobalt 60
cpm	counts per minute
Cs-137	Cesium 137
CTO	Contract Task Order
DAC	derived air concentration
DCGL	derived concentration guideline level
$\text{DCGL}_{\text{EMC}}$	DCGL for elevated measurement comparison
$\text{DCGL}_{\text{W}}$	wide-area DCGL
DoD	Department of Defense
DON	Department of the Navy
DOT	Department of Transportation
dpm	disintegrations per minute
DQO	data quality objective
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
FSS	Final Status Survey
GPS	Global Positioning System
G-RAM	general radioactive material
H-3	Tritium
HASP	Health and Safety Plan
HRA	Historical Radiological Assessment
ISO	International Organization for Standardization
LBGR	lower boundary of the gray region
m	meter
$\text{m}^2$	square meter

## ABBREVIATIONS AND ACRONYMS

(Continued)

MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MDCR <sub>SURVEYOR</sub>	MDCR calculated assuming a surveyor efficiency
MDER	minimum detectable exposure rate
MeV	megaelectron volt
min	minute
mrem	millirem
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/mL	picocuries per milliliter
PMO	Program Management Office
PPE	personal protective equipment
PSPC	Position Sensitive Proportional Counter
QC	quality control
QL	Quantitation Limit
Ra-226	Radium 226
RASO	Radiological Affairs Support Office
RCT	Radiological Control Technician
RML	Radioactive Materials License
RPM	Remedial Project Manager
RPP	Radiation Protection Plan
RSO	Radiation Safety Officer
RSOR	Radiation Safety Office Representative
RSSI	Radiation Survey and Site Investigation
RWP	Radiation Work Permit

## **ABBREVIATIONS AND ACRONYMS**

(Continued)

SAP	Sampling and Analysis Plan
SCM	Surface Contamination Monitor
SOP	Standard Operating Procedure
Sr-90	Strontium 90
SS	Shift Supervisor
SSO	Site Safety Officer
Th-232	Thorium 232
TSP	Task-specific Plan
Tt	Tetra Tech
TtEC	Tetra Tech EC, Inc.
U-238	Uranium 238
WRS	Wilcoxon Rank-Sum (test)
y	Year

## 1.0 INTRODUCTION

This Basewide Radiological Management Plan (Management Plan) describes survey and decontamination procedures and methodologies that will be implemented in support of radiological release of buildings, sites, structures, areas, materials and equipment, and personnel at Naval Air Station (NAS) Joint Reserve Base (JRB) Willow Grove, Willow Grove, Pennsylvania. Tetra Tech, Inc. (Tt) was contracted by the Department of the Navy (DON) to prepare this Management Plan for these radiological activities at NAS JRB Willow Grove under Contract Task Order (CTO) WE03, Contract No. N62470-08-D-1001 for the Base Realignment and Closure (BRAC) Program Management Office (PMO) Northeast under Naval Facilities Engineering Command LANT (NAVFAC LANT). The methodologies and processes described in this Management Plan apply to operational radiological activities performed by Tt in relation to its projects at NAS JRB Willow Grove and may guide the preparation of other work plans by radiological contractors as directed by the DON. All radiological activities identified for this project will be performed under the Tetra Tech EC, Inc. Nuclear Regulatory Commission Radioactive Materials License, license number 29-31396-01 ([Attachment 1](#)) and in accordance with the Radiation Protection Plan (RPP) [[Attachment 2](#)].

The most current version of the Sampling and Analysis Plan (SAP) [[Attachment 3](#)] should be implemented during field activities.

A basic concept in radiation protection specifies that exposures to ionizing radiation and releases of radioactive material should be managed to reduce collective doses to workers and the public and ensure that exposure is as low as reasonably achievable (ALARA). The ALARA principle will be considered during the course of the radiological work carried out under the Management Plan for survey activities.

The objective of this Management Plan is to provide the radiological procedures and methodologies for:

- Evaluating impacted sites, structures, buildings, areas, material and equipment, and other items that may contain residual radioactivity above the release criteria as a result of past activities at NAS JRB Willow Grove
- Removing identified radioactive contamination
- Confirming that the release criteria have been met

The radiological activities that support the objective of the Management Plan include:

- Reference (Background) Surveys
- Scoping surveys

- Characterization surveys
- Remedial action support surveys
- Final Status Surveys (FSSs)
- Personnel surveys
- Equipment and material Surveys
- Truck surveys
- Decontamination and dismantling

Where applicable, radiological survey activities will be conducted in accordance with the guidelines in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Nuclear Regulatory Commission (NRC) NUREG-1575 (DoD et al. 2000), as incorporated into this Management Plan. Other survey activities as well as activities not addressed by MARSSIM will be performed in accordance with this Management Plan and the Standard Operating Procedures (SOPs) and applicable work instructions. Table 1-1 lists each of the Tt field SOPs developed for performing radiological work at NAS JRB Willow Grove. Copies of the SOPs as well as work instructions are available in the Tt offices at NAS JRB Willow Grove, when mobilized, and can be provided to the DON and regulatory agencies for review upon request.

This Management Plan is organized as follows:

**Section 1.0 Introduction** – Section 1.0 provides an overview of the project scope, work objectives, and organization of the Management Plan.

**Section 2.0 Background** – Section 2.0 describes NAS JRB Willow Grove, provides a historical summary of the Base, and includes an overview of the radiological history of NAS JRB Willow Grove, including impacted sites.

**Section 3.0 Key Radiological Personnel and Work Control Procedures** – Section 3.0 discusses the project organization, roles and responsibilities of key project personnel, personnel qualifications, and work control activities.

**Section 4.0 Radiological Survey Types, Area Classification, and Selection** – Section 4.0 identifies the types of surveys that will be conducted, and discusses survey area classification and survey type selection.

**Section 5.0 Survey Overview** – Section 5.0 presents an overview of survey planning, survey implementation, and data assessment.

**Section 6.0 Release Criteria and Investigation Levels** – Section 6.0 identifies the criteria for radiological release for unrestricted use.

**Section 7.0 Instrumentation** – [Section 7.0](#) identifies field instrumentation that will be used to perform surveys.

**Section 8.0 Survey Implementation** – [Section 8.0](#) presents the approach to implementing surveys that will be conducted as well as associated sampling activities.

**Section 9.0 Decontamination, Dismantling, and Disposition** – [Section 9.0](#) discusses the survey and construction activities that will be implemented to perform remedial action at sites contaminated by radiation above release limits.

**Section 10.0 Radioactive Materials Management** – [Section 10.0](#) describes how radioactive materials will be managed, including control of samples, work areas, and wastes.

**Section 11.0 Documentation and Records Management** – [Section 11.0](#) presents procedures that will be used to manage records/documentation, as well as to assess, interpret, and report data.

**Section 12.0 References** – [Section 12.0](#) presents references cited in this Management Plan.

## **2.0 BACKGROUND**

The following sections provide the location and description, a general site history, and a brief radiological history of NAS JRB Willow Grove.

### **2.1 NAS JRB WILLOW GROVE LOCATION AND DESCRIPTION**

NAS JRB Willow Grove is located in Montgomery County, Pennsylvania, about 25 miles north of Philadelphia, Pennsylvania. The facility includes three principal areas: the Main Station, the Jacksonville Road Housing Area and the Shenandoah Woods Housing Area. The Main Station encompasses approximately 1,100 acres and is surrounded primarily by the commercial areas of State Route 611 toward the east, Horsham Road to the southwest, Keith Valley Road to the north, and County Line Road to the northeast. The Jacksonville Road Housing Area has 6 single family homes situated on approximately 2.5 acres and is located six miles northeast of the Main Station in neighboring Ivyland Borough in Bucks County. The Shenandoah Woods Housing Area has 199 townhouse units situated on approximately 51 acres and is located eight miles northeast of the Main Station in Warminster in Bucks County. Jacksonville Road Housing was transferred in May 2013 to Ivyland Borough and the Navy is currently in the process of transferring Shenandoah Woods Housing in accordance with the Horsham Land Redevelopment Authority's Redevelopment Plan and Homeless Assistance Submission.

### **2.2 GENERAL SITE HISTORY**

The original land consisting of NAS JRB Willow Grove was acquired by the Navy in 1942 from Harold Pitcairn and was formally commissioned NAS Willow Grove in July 1943. In 1957, the Navy purchased additional land bordering the Station to bring the total land area of the Station to approximately 1,100 acres. In 1994, the Station's name was changed to Naval Air Station Joint Reserve Base, Willow Grove, to more accurately reflect the mission of the Station, which at that time supported the Navy, Marine Corps, and Air Force, Army Reserve and Pennsylvania Air National Guard. Under the BRAC law in 2005, NAS JRB Willow Grove was selected for realignment and closure and the Station entered into caretaker status on September 15, 2011.

### **2.3 RADIOLOGICAL HISTORY**

As part of the environmental investigations being performed to facilitate transfer of NAS JRB Willow Grove, the Naval Sea Systems Command prepared a Historical Radiological Assessment (HRA) [Tetra Tech 2012] that documents the history of radiological materials at NAS JRB Willow Grove. The HRA (Tetra Tech 2012) presents the history of general radioactive material (G-RAM) at NAS JRB Willow Grove.

The HRA (Tetra Tech 2012) concluded that areas potential radiological contamination is present at NAS JRB Willow Grove and identified additional investigations to support transfer and reuse. This Management Plan was prepared to address the recommendations presented in the HRA (Tetra Tech 2012).

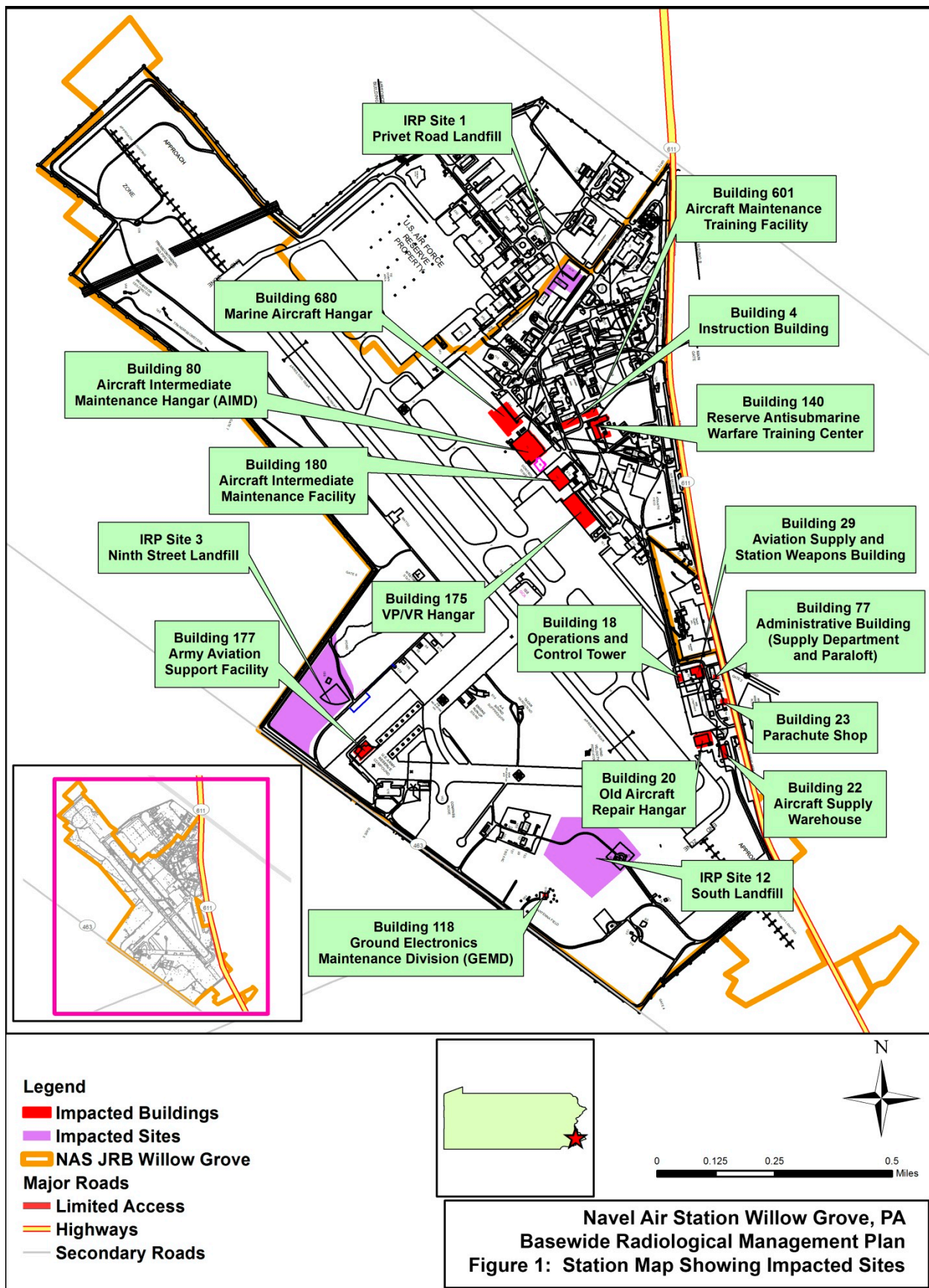
According to the HRA ([Tetra Tech 2012](#)), devices incorporating radioluminescent radium paint came into wide use in the Navy beginning in the late 1930s. These devices constituted the first G-RAM introduced to NAS JRB Willow Grove. Other G-RAM used at NAS JRB Willow Grove as part of routine naval aviation activities included:

- Other radioluminescent devices
- Sources for calibrating radiation-detection instruments
- Materials found in items such as smoke detectors, welding rods, and night vision equipment, survival equipment, electron tubes, spark gap irradiators and depleted uranium (DU) counterweights

The use and/or handling of these materials may have resulted in radiological contamination at NAS JRB Willow Grove.

In accordance with MARSSIM ([DoD et al. 2000](#)), an “impacted site” is defined as one that has a potential for radioactive contamination based on historical information or is known to have radioactive contamination. Based on the review of historical radiological operations at NAS JRB Willow Grove, the HRA ([Tetra Tech 2012](#)) concluded that 18 sites were impacted.

The HRA ([Tetra Tech 2012](#)) recommended 18 sites at NAS JRB Willow Grove for further investigation, including scoping surveys, by the DON. Specific recommendations for surveys at each of the 18 areas were presented in the HRA ([Tetra Tech 2012](#)). Site locations are shown on Figure 1.



### **3.0 KEY RADIOLOGICAL PERSONNEL AND WORK CONTROL PROCEDURES**

This section describes the responsibilities of key personnel necessary for management of radiological activities at NAS JRB Willow Grove. In addition, this section identifies the minimum training requirements for workers at NAS JRB Willow Grove and work control procedures including Task Specific Plans (TSPs), Radiation Work Permits (RWPs), and radiological notifications.

#### **3.1 KEY RADIOLOGICAL PERSONNEL**

Specific personnel are essential in performing radiological activities at NAS JRB Willow Grove. Qualified and experienced personnel will fulfill the necessary functions to ensure the consistent and successful implementation of radiological work activities at NAS JRB Willow Grove. All key radiological personnel are expected to have the requisite skills necessary to perform these functions. A Project Organizational Chart can be found on Worksheet #5 of the Sampling and Analysis Plan (SAP) [[Attachment 3](#)]. The key radiological personnel include the following:

##### **3.1.1 Radiation Safety Officer**

The Radiation Safety Officer (RSO) is responsible for implementing, directing, and supervising all radiological project-related activities. The RSO has the responsibility and authority to perform the following:

- Providing oversight of implementation and ensuring compliance with the applicable NRC (or Agreement State, if applicable) Service Provider Radioactive Materials License (RML)
- Serving as contact for NRC site inspections
- Assisting DON representatives during site audits
- Controlling exposure conditions for site workers
- Implementing a dosimetry program for all site workers entering radiologically controlled areas
- Enforcing radiological controls
- Coordinating radiological activities with other NRC or Agreement State licensed contractors
- Ensuring all radiological work activities comply with RML requirements
- Identifying radiological analysis needs
- Providing health physics guidance on an as-needed basis
- Providing radiological control protection services, if required

- Directing and assisting radiological personnel in proper completion of radiological records
- Assisting the Radiation Safety Officer Representative (RSOR) to determine if an external dose is to be assigned to an individual who reported lost or damaged dosimetry devices
- Reviewing all changes to the SAP to ensure radiological requirements are met
- Ensuring that the required radiological safety training is provided
- Reviewing and approving project field procedures associated with the handling of radioactive materials or access to radiological areas
- Ensuring timely and thorough review of records, in accordance with the NLP-07 Radiological Records corporate SOP, prior to approval
- Approving records with verifiable signature and date once records meet the quality standards as described in the NLP-07 Radiological Records corporate SOP
- Conducting radiation incident investigations
- Conducting radiological inspections
- Conducting data assessments and evaluations

### **3.1.2 Radiation Safety Officer Representative**

The RSOR will report directly to the RSO and will perform on-site duties as designated by the RSO. In accordance with DON requirements, the RSO or a qualified designee will be on-site during radiological work activities conducted under this Management Plan. The RSOR has the responsibility and authority to perform the following:

- Implementing, directing, and supervising on-site radiological activities
- Assisting in identifying radiological analysis needs
- Providing health physics guidance
- Assisting in establishment of radiological controls
- Overseeing preparation and approval of radiological documents and field procedures
- Establishing personnel monitoring requirements
- Establishing, implementing, and monitoring on-site radiological training programs
- Conducting assessments of field practices and procedures
- Reviewing and approving data from radiological investigations, surveys, and remediation
- Assisting the RSO in ensuring adequate radiological controls are in place at the work site
- Assuring that specified radiological safety procedures are followed and that the radiological safety tests and inspections are complete and acceptable

- Conducting daily oversight and field safety inspections and tests required by the project technical specifications and applicable professional standards
- Attending required meetings, including weekly quality control (QC) meetings, pre- and post-construction site inspections, and other scheduled and unscheduled meetings
- Administering the on-site dosimetry program
- Verifying compliance with on-site RWPs and SOPs
- Assisting the RSO in reviewing changes to the SAP to ensure radiological requirements are met
- Approving issuance of any work document pertaining to radiological safety issues
- Providing surveillance of radiological-related activities
- Assisting the RSO in directing the production of radiological work documents and reports
- Ensuring that a Subcontract Project Manager (SPM) or designee will be on-site during radiological activities
- Conferring with radiological personnel to provide technical advice and to resolve problems
- Preparing daily project status reports
- Notifying the RSO regarding radioactive anomalies
- Managing the storage of radioactive waste in accordance with the RML

### **3.1.3 Subcontract Project Manager (SPM)**

The SPM or designee will direct field survey personnel and health physics operations as assigned by the RSO, RSOR, or designee. The SPM has the responsibility and authority to perform the following:

- Overseeing task-specific radiological field activities for compliance with the RML and approved plans, work instructions, SOPs, instrument specifications, and state-of-the-art health physics practices
- Coordinating task-specific activities with the RSOR
- Preparing RWPs to outline field conditions, radiological control requirements, and personal protective equipment requirements in the field for RSO approval
- Being physically on-site when radiological operations are performed by field staff
- Ensuring all field staff are properly trained and comply with the RWP
- Supervising field staff during survey, site remediation, and decontamination activities, use of survey equipment and instrumentation, and support of other radiological activities

- Ensuring compliance with the applicable SOPs for safety program, survey, and/or remediation activities
- Interpreting and verifying task-specific data accumulated during surveys and monitoring activities
- Ensuring compliance with TSPs, as directed by the RSO and RSOR

#### **3.1.4 Site Supervisor (SS)**

The SS is responsible for organizing, scheduling, and implementing field activities. The SS has the responsibility and authority to perform the following:

- Implementing the TSPs and ensuring proper collection of radiation data for this project
- Primary on-site point of contact for other team personnel
- Ensuring the proper calibration and operation of radiological monitoring equipment and ensures that field activities are conducted in accordance with the management plan, the TSPs, and applicable procedures and regulations
- Implementing the HASP with regard to radiological issues including implementation of dosimetry, air sampling, surveys for radiation protection and the RWP program as necessary. The SS works with the Site Safety Officer (SSO) to ensure that safety issues are identified and addressed and that field activities are performed in a safety conscious manner.
- Implementing any site-specific radiation programs. The SS works closely with the SPM and RE and site-specific field team members to ensure the adequacy and appropriateness of radiation safety measures in including the need for RWPs during surveys and material removal activities
- Ensuring that the survey objectives are met and to provide assistance in resolving technical issues in the field. The SS directs the day-to-day field activities of the technicians. The SS works directly with the SPM and Radiological Engineer to ensure tasks are implemented in accordance with this management plan and the TSPs
- Maintaining schedule adherence and for reporting issues of nonconformance to the SPM.
- Ensuring the technical defensibility of the data collected as part of this survey effort. The SS has stop work authority for all project activities.

#### **3.1.5 Radiological Engineer (RE)**

The RE has the responsibility and authority to perform the following:

- Ensuring that field activities are performed in accordance with the requirements of this management plan and the TSPs

- Working with the SPM and SS for planning, coordinating, integrating, monitoring, and managing project activities
- Responsible for the review and acceptance of data in support of the determination of background and instrument efficiency
- Validating of data generated during field surveys. The RE, in conjunction with the SS, develops the survey report for each of the buildings and land area included in the scope of this management plan.

### **3.1.6 Project Health Physicist (PHP)**

The PHP has the responsibility and authority to perform the following:

- Assisting in the development and approval of the management plan and TSPs and in the identification of radiological data needs
- Providing technical support for field activities, health physics guidance on an as-needed basis, and radiological control protection services, if required
- Assisting project personnel in proper completion of radiological records, reviews and approves project field procedures that involve handling radioactive materials or access to radiological areas, and conducts radiation incident investigations and project inspections
- Coordinating with the analytical laboratory and data validator to assure proper implementation of SAP/QAPP requirements.

### **3.1.7 Site Safety Officer (SSO)**

The SSO has the responsibility and authority to perform the following:

- Implementation of the HASP, in accordance with site-specific safety protocols
- Identifying safety hazards and ensuring that they are adequately addressed prior to field activities
- Implementing the medical monitoring program for this project
- In concert with the SS and RE, the SSO reviews field-monitoring data and authorize upgrades or downgrades in personal protective equipment (PPE)
- Performing field safety audits during sampling activities.

### **3.1.8 Radiological Control Technicians**

Radiological Control Technicians (RCTs) will support projects in the field and have the responsibility and authority to perform the following:

- Performing radiological field activities under the direction of the SPM or RSOR in accordance with approved work documents and RML requirements

- Documenting field survey activities in accordance with the Management Plan, TSPs, and SOPs
- Interpreting and verifying field data gathered during survey and monitoring activities
- Supporting dose assessments, and assuring compliance with emergency plans, and procedures
- Performing effluent monitoring and radioactive material inventories
- Performing survey equipment response checks, and daily checks of the survey instruments
- Conducting safety evaluations of health physics field and laboratory equipment
- Implementing use of RWPs, including being present at active work areas to ensure compliance in the absence of the SPM

### **3.2 MINIMUM TRAINING REQUIREMENTS**

The minimum training requirements for personnel working in the field at NAS JRB Willow Grove include the following:

- Occupational Safety and Health Administration 40-Hour and Annual 8-Hour Refresher
- Radiation awareness and RWP training
- TSP training for the specific site or task
- Training as required by the implemented Health and Safety Plan (HASP)

### **3.3 WORK CONTROL PROCEDURES**

Prerequisites for the initiation of survey activities include review of the associated TSP, radiological evaluation of the designated work areas, and identification of any potential safety concerns. Work control procedures include the preparation and review of TSPs, RWPs, work instructions, and appropriate notifications of anomalies or significant radiological events.

#### **3.3.1 Task-specific Plan**

The Management Plan provides the procedures and methodologies for performing radiological activities that will be implemented in support of radiological release of buildings, sites, structures, areas, materials and equipment, and personnel at NAS JRB Willow Grove. TSPs will be prepared for surveys and remediation performed under the Management Plan and will provide supplemental information. Each TSP will provide relevant location-specific data and identify variances and/or additions to the Management Plan. Substantial deviations from the Management Plan may result in the generation of a stand-alone, job-specific work plan. Where prepared, these stand-alone work plans will supersede this Management Plan, but may utilize certain portions of the Management Plan where indicated.

At a minimum, each TSP will include the following information:

- Task description, including the specific location history, purpose of the task, and the radionuclides of concern
- Data quality objectives (DQOs) defined to a level sufficient to ensure that the data obtained will support the goals of the task
- An activities plan consisting of a survey description and discussion of additional activities necessary to support the survey, which will include a description of applicable specific construction or decontamination and decommissioning activities (as required)
- Specific identification of variations, if any, to the Management Plan, including the requirement and variations, and the technical justification for the variations
- Specific survey figures (as required) that provide sampling and survey data points and other figures necessary to support the activity
- Attachments (as necessary) to provide further description, information, or delineation of the task activities

Each TSP will be provided to the BRAC PMO and the Radiological Affairs Support Office (RASO) for review and approval.

### **3.3.2 Radiological Health and Safety**

SOPs and work instructions will be used to address controls necessary for radiologically safe operations and referenced as necessary in appropriate TSPs. [Table 1-1](#) lists each of the Tt field SOPs developed for performing radiological work at NAS JRB Willow Grove. Copies of the SOPs as well as work instructions are available in the Tt offices at NAS JRB Willow Grove, when mobilized, and are available for review by the DON and regulatory agencies upon request.

Dose rate, contamination, and air monitoring, including initial baseline sampling to determine radiological background conditions, will be performed as necessary and in accordance with the HASP. Field activities will be performed in accordance with the approved RWP and HASP. RWPs will be prepared in accordance with the applicable Radiation Protection Plan (RPP) [[Attachment 2](#)] and SOP 002, Issue and Use of Radiation Work Permits. Personnel protective equipment (PPE) levels, dictated by radiological considerations and physical and chemical safety issues identified at each work location, will be assigned or modified, according to the approved RWP and HASP and SOP 022, Radiological Protective Clothing Selection, Monitoring, and Decontamination.

### **3.3.3 Task-specific Work Instructions**

In limited situations involving ancillary radiological activities (e.g., monitoring well installation or destruction in radiologically impacted areas, or decontamination with a vacuum system), or to

further augment TSPs or SOPs, radiological work instructions may be prepared to facilitate a specific activity. These radiological work instructions, when used, will be provided to the BRAC PMO and the RASO for review and approval. Copies of the work instructions are available in the Tt offices at NAS JRB Willow Grove, when mobilized, and can be provided to the DON and regulatory agencies for review upon request.

#### **3.3.4 Notifications**

During survey activities, radioactive anomalies may be identified and significant radiological events could occur. For the purposes of the Management Plan, an anomaly is described as a reading or result that appears to be an outlier in the professional judgment of the RSOR. When an anomaly is identified, the RSOR will notify the RSO who will notify the BRAC PMO Remediation Project Manager (RPM) and the RASO. If the RSO is unavailable, the RSOR will leave a voice mail and confirmatory e-mail describing the anomaly and follow up with a call to the appointed designee, if any.

Significant events include regulatory visits (such as by the NRC or other regulatory agencies), radiological issues, injuries, and breaches in security. All significant events will be disclosed to the RPM and RASO as described above. Any radiological issues will also be reported to the RSO.

## **4.0 RADIOLOGICAL SURVEY TYPES, AREA CLASSIFICATION, AND SELECTION**

Several types of radiological surveys will be conducted at NAS JRB Willow Grove. Surveys, as recommended in the HRA, will be used to support the release of materials, equipment, open areas, utilities and/or buildings; support remedial actions; identify radionuclides and levels of contamination present; and support unforeseen work that may be necessary. The surveys shall be robust to suffice at a minimum a MARSSIM scoping survey and if warranted fulfill a complete Final Status Survey.

### **4.1 SURVEY TYPES**

This section describes the types of surveys that may be performed at NAS JRB Willow Grove.

#### **4.1.1 Reference (Background) Area Survey**

The reference area is a geographical area or structure from which representative radioactivity measurements are performed for comparison with measurements performed in an impacted area. The reference area selected should have physical, chemical, radiological, and biological characteristics similar to the impacted area(s) being investigated. The reference area must not be identified as impacted by the HRA ([Tetra Tech 2012](#)). All on-site and off-site locations selected as reference areas will be approved by the RSO or RSOR. The same survey methods and equipment that will be used for conducting a survey in an impacted area will be used for the background area survey. Reference area data will normally be provided to the RSO prior to the start of a survey.

#### **4.1.2 Scoping Survey**

Scoping surveys provide site-specific information based on limited measurements. Scoping surveys are to be conducted as indicated by the HRA ([Tetra Tech 2012](#)) with guidance from MARSSIM ([DoD et al. 2000](#)) and will consist of judgment measurements based on applicable information in the HRA ([Tetra Tech 2012](#)) and professional experience. Sufficient information will be collected to identify situations that require immediate radiological attention or to support development of other project activities.

The primary objectives of scoping surveys are to:

- Perform a preliminary contamination assessment
- Identify radionuclide contaminants
- Assess radionuclide ratios
- Assess general levels and extent of radionuclide contamination, if present
- Support classification of impacted areas

- Evaluate whether the survey strategy can be optimized for use in a characterization survey or FSS

#### **4.1.3 Characterization Survey**

The characterization survey is performed to determine the nature and extent of radiological contamination at the site. This includes preparing a reference grid, collecting systematic as well as judgment measurements, and performing surveys of different media (e.g., surface soils, interior and exterior surfaces of buildings). The decision as to which media will be surveyed is a site-specific decision addressed throughout this Management Plan and each TSP.

Characterization surveys are planned based on the HRA ([Tetra Tech 2012](#)), MARSSIM ([DoD et al. 2000](#)) guidance, and/or scoping survey results. The primary objectives of characterization surveys are to:

- Assess the nature and extent of the contamination, if present
- Collect data to support evaluation of remedial alternatives and technologies
- Evaluate whether the survey strategy can be optimized for use in the FSS
- Provide input to the FSS design

#### **4.1.4 Remedial Action Support Survey**

Remedial action support surveys are performed to assess the effectiveness of the remedial action while remediation is being conducted, and to guide the cleanup in a real-time mode. The primary objectives of remedial action support surveys are to:

- Support remediation activities
- Assess when an area is ready for the FSS
- Provide site-specific information used for planning the FSS

#### **4.1.5 Final Status Survey**

The FSS provides data to demonstrate that radiological parameters satisfy the established guideline values and conditions for radiological release. Data from other surveys conducted during the course of site investigations at NAS JRB Willow Grove—such as scoping, characterization, and remedial action support surveys—can provide valuable information for planning an FSS. The primary objectives of FSSs are to:

- Verify classification
- Demonstrate that the potential dose or risk from residual activity is below the release criterion

- Demonstrate that the potential dose or risk from small areas of elevated activity is below the release criterion

#### **4.1.6 Personnel Surveys**

Surveys will be performed on personnel leaving a radiological area to ensure that individuals are free of radiological contamination as identified in the applicable RPP ([Attachment 2](#)).

#### **4.1.7 Equipment and Materials Surveys**

Before being put into service or leaving a radiological work area, equipment and/or materials will be surveyed in an area of low background concentrations to ensure that the equipment and materials release criteria are not exceeded, using appropriate SOPs.

- Equipment and/or materials being put into service in a radiological work area at NAS JRB Willow Grove that exceed the release criteria will be returned to the supplier for replacement or decontamination.
- Outgoing equipment and/or materials that do not meet the release criteria will be decontaminated before leaving the radiological work area or stored for disposal.

### **4.2 SURVEY AREA CLASSIFICATION**

The HRA ([Tetra Tech 2012](#)) has identified areas at NAS JRB Willow Grove that have been classified as impacted. Based on available information from the HRA ([Tetra Tech 2012](#)), each area will be given a classification. Impacted areas are divided into one of three classifications as described below.

#### **4.2.1 Class 1 Areas**

Class 1 areas have (or had prior to remediation) a potential for radioactive contamination. This potential is based on site operating history. Examples of Class 1 areas include:

- Site areas previously subjected to remedial actions
- Locations where leaks or spills are known to have occurred
- Former burial or disposal sites
- Waste storage sites
- Areas designated as such in the HRA ([Tetra Tech 2012](#))

#### **4.2.2 Class 2 Areas**

Class 2 areas have (or had prior to remediation) a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGL<sub>W</sub>. Examples of Class 2 areas include:

- Locations where radioactive materials were present in an unsealed form

- Potentially contaminated transport routes
- Areas downwind from stack release points
- Upper walls and ceilings of buildings or rooms subjected to airborne radioactivity
- Areas handling low concentrations of radioactive materials
- Areas designated as such in the HRA ([Tetra Tech 2012](#))
- Buffer areas on the perimeter of Class 1 areas

#### **4.2.3 Class 3 Areas**

Class 3 areas are not expected to contain residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the  $DCGL_W$ , based on site operating history and previous radiation surveys. Examples of Class 3 areas include:

- Buffer zones around Class 1 or Class 2 areas
- Areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification
- Areas designated as such in the HRA ([Tetra Tech 2012](#))

### **4.3 CLASSIFICATION AND SURVEY UNIT SIZE**

A survey unit is a physical area consisting of structures or land areas of specified size and shape for which a separate decision will be made as to whether or not that area exceeds the release criterion. This decision is made as a result of the FSS. As a result, the survey unit is the primary entity for demonstrating compliance with the release criteria.

Survey units will be limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. The limitation on survey unit size for Class 1 and Class 2 areas ensures that each area is assigned an adequate number of data points. [Table 4-1](#) lists the survey unit sizes.

### **4.4 REFERENCE COORDINATE SYSTEMS**

A reference coordinate system will be laid out for each survey unit to identify survey/sample locations. Two different grid systems, as specified in MARSSIM ([DoD et al. 2000](#)), may be used. Although the preferred method is the triangle grid, the specific TSP will specify the grid system to be used.

#### **4.4.1 Square Grid**

A square grid system may be used for Class 1 and Class 2 survey units. For Class 3 survey units, a square grid system can be used, if specified in the TSP. The length,  $L$ , of a side of the square grid is determined by the total number of samples or measurements to be taken. The length of

the square will determine the distance between survey data points. The length or spacing of the grids will be calculated for each of the survey units using the following equation:

**Equation 4-1**

$$L = \sqrt{\frac{A}{N}}$$

Where:

- $L$  = length of spacing (meters [m])
- $A$  = surface area of the survey unit (square meters [m<sup>2</sup>])
- $N$  = number of data points

Grid locations are then positioned throughout the survey unit by first randomly selecting a start point and establishing a systematic pattern. Random numbers for the square grid method, between zero and one, are determined for both the X and Y locations in each survey unit. The random number is then multiplied by the  $L$  (length of square grids) to determine both the starting X and Y locations in each survey unit. The length  $L$  is then used to determine all remaining data points based on this starting location.

#### 4.4.2 Triangular Grid

A triangular grid system may be used for Class 1 and Class 2 survey units, but will not normally be used in Class 3 survey units. The length between triangular grid data points ( $L$ ) is determined by the total number of samples or measurements to be taken, using the following equation:

**Equation 4-2**

$$L = \sqrt{\frac{A}{0.866 * N}}$$

Where:

- $L$  = length of spacing (m)
- $A$  = surface area of the survey unit (m<sup>2</sup>)
- $0.866$  = constant factor from MARSSIM (sine of 60 degrees)
- $N$  = number of data points

A second row of points is then developed, parallel to the first row, at a distance of  $0.866 \times L$  from the first row. Survey points along that second row are midway (on the X-axis) between the points on the first row. This process is repeated to identify a pattern of survey locations throughout the survey unit. If identified points fall outside the survey unit or at a location that cannot be surveyed, additional points are determined using the random process described above, until the desired total number of points is identified.

The triangular grid system is generally more efficient for locating small areas of elevated activity. A more detailed discussion is provided in Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3: Reference Based Standards for Soils and Solid Media ([EPA 1994](#)).

#### **4.5 SURVEY TYPE SELECTION**

The type of survey selected for an area or survey unit will be specified by either the recommendations contained in the HRA ([Tetra Tech 2012](#)) or discussions and technical direction from the RASO. The exception will be remedial action support surveys, personnel surveys, equipment and material surveys, and truck surveys that will be used as necessary to assess the effectiveness of decontamination activities and to release personnel, equipment, and material.

The survey progression is reassessed typically when a survey unit fails to meet the release criterion during an FSS effort. If a Class 2 or 3 survey unit fails to meet the criterion for release, it will undergo decontamination or remedial actions, where necessary, and be reclassified as a Class 1 unit for the follow-up survey actions. If a Class 1 survey unit fails to meet the release criterion, decontamination and remedial action support surveys will be performed. A Class 1 survey will follow decontamination or remedial activities.

## 5.0 SURVEY OVERVIEW

This section provides an overview of survey planning and design, implementation, and data assessment. Survey details are given in later sections of this Management Plan. Additional details will be provided in the project-specific TSPs, as appropriate.

### 5.1 DATA LIFE CYCLE

Compliance demonstration is simply a decision as to whether or not a survey unit meets the release criterion. This decision is based on the results of one or more surveys. Positive actions must be taken to manage the uncertainty in the survey results so that sound, defensible decisions may be made. These actions include proper survey planning to control known causes of uncertainty, proper application of QC procedures during implementation of the survey plan to detect and control significant sources of error, and careful analysis of uncertainty before the data are used to support decision making. These actions describe the flow of data throughout each type of survey, referred to as the Data Life Cycle.

There are four phases of the Data Life Cycle:

- *Planning Phase.* The survey design is developed and documented using the DQO process, which is summarized in [Section 5.2.3](#).
- *Implementation Phase.* The survey design is carried out in accordance with the TSPs resulting in the generation of raw data. In addition, quality assurance and QC measurements will generate data and other important information that will be used during the Assessment Phase.
- *Assessment Phase.* The data generated during the Implementation Phase are first verified to ensure that the TSPs were actually followed and that the measurement systems were performed in accordance with the criteria specified in this plan. Then the data are validated to ensure that the results of data collection activities support the objectives of the survey, as documented in the applicable TSP, or permit a determination that these objectives should be modified.
- *Decision-making Phase.* A decision is made, in coordination with the responsible regulatory agency, based on the conclusions drawn from the assessment process. The ultimate objective is to make technically defensible decisions with a specified level of confidence.

### 5.2 SURVEY PLANNING

The Radiation Survey and Site Investigation (RSSI) process includes a series of surveys that will be used at NAS JRB Willow Grove to demonstrate compliance with the release criterion. This process will be used as a framework for collecting the information required for scoping,

characterization, remediation, and FSS activities. The methodology used at NAS JRB Willow Grove to implement the RSSI process consists of the following six principal steps:

1. Site identification
2. Historical site assessment
3. Scoping survey
4. Characterization survey
5. Remedial action support survey
6. FSS

Table 5-1 provides a simplified overview of the principal steps in the RSSI process and how the Data Life Cycle can be used in an iterative fashion within the process.

Figure 2.4 of MARSSIM (DoD et al. 2000) illustrates the RSSI process in terms of area classification and lists the major decision to be made for each type of survey. The flow chart, illustrated in Figures 2.5 through 2.8 of MARSSIM, presents the principal steps and decisions in the site investigation process and shows the relationship of the survey types to the overall assessment process.

### 5.2.1 Survey Design Elements

Survey and sampling process design includes, but is not limited to, the following elements:

- The *types of samples and sampling matrices* for the survey; solid samples for outdoor surveys and fixed measurements for indoor surveys
- The *measurement frequency* for direct measurement locations for each survey unit and scan percentage of each survey unit
- The *sampling frequency* for solid sample collection locations in the survey unit(s)
- The *methods* for performing remedial action support surveys and other ancillary surveys

However, before these elements can be established, a general strategy must be determined.

### 5.2.2 Survey Strategy

Strategies for implementing the various survey types at NAS JRB Willow Grove are provided in Table 5-2. The selection of specific survey types for each area investigated under the Management Plan will be based on information in the HRA (Tetra Tech 2012) and will be identified in each corresponding TSP. For an FSS, the standard survey strategy will be based on using a MARSSIM (DoD et al. 2000) Scenario A approach, as described in Section 5.5.3. On a case-by-case basis, as identified in a TSP, the FSS design using the Scenario B approach will be considered.

### **5.2.3 Data Quality Objectives**

MARSSIM recommends using the seven-step DQO process in the design of radiological surveys. This process tailors the survey to the particular conditions of each survey situation. DQO elements are applicable to all the surveys to be performed under this Management Plan. Specific DQOs for each survey will be established in the relevant TSP.

The seven steps in the DQO process are as follows:

1. State the problem
2. Identify the goal of the study
3. Identify information inputs
4. Define the boundaries of the study
5. Develop the analytical approach
6. Specify performance or acceptance criteria
7. Develop the plan for obtaining data

## **5.3 SURVEYS**

Survey implementation for each type of survey to be conducted at NAS JRB Willow Grove is discussed below. While implementation requires instrumentation and survey techniques, this section will concentrate on the general approach. The instrumentation to be used is discussed in [Section 7.0](#) and survey techniques are presented in [Section 8.0](#). Other survey specifics will be presented in the TSP.

### **5.3.1 Scoping and Characterization Surveys**

These surveys will be implemented as described in their individual TSPs. In practice, scoping and characterization survey data that indicate that the residual activity is below the derived concentration guideline level (DCGL) for the building/area will be used in the FSSs where possible.

### **5.3.2 Remedial Action Support Surveys**

These surveys are implemented during the remedial activity. For example, surveys to support remediation would follow the decontamination work to assess progress.

### **5.3.3 Final Status Surveys**

For the FSS, the data analysis framework is critical to survey development because it drives the sampling requirements. For contaminants present in background, the analysis uses the Wilcoxon Rank-Sum (WRS) test. For contaminants not present in background, the analysis uses the Sign test. In each case, the minimum number ( $N$ ) of samples (or fixed measurements) is calculated as

follows: the method to calculate any additional number of required data points is stated in [Section 6.1](#), and grid spacing methods and requirements are listed in [Section 4.4](#). The statistical tests are described in [Section 5.4](#).

### 5.3.3.1 Determination of the Relative Shift

Using Equation 5-1, the value of the relative shift can be determined. For single radionuclide analysis, the values for the lower boundary of the gray region (LBGR) will be set at half the DCGL during the planning phase, and at the median concentration in a survey unit for the data assessment phase.

When analyzing multiple radionuclides, the values for the LBGR and  $\sigma$  are determined using [Section 6.2](#)

#### *Equation 5-1*

$$\frac{\Delta}{\sigma} = \frac{DCGL_W - LBGR}{\sigma}$$

Where:

$$\begin{aligned} DCGL_W &= DCGL_W \text{ as appropriate} \\ LBGR &= \text{lower boundary of the gray region, as appropriate} \\ \sigma &= \text{standard deviation from the survey unit, as appropriate} \end{aligned}$$

The value of the relative shift is used with the appropriate random measurement probability presented in MARSSIM ([DoD et al. 2000](#)) Tables I.2a and I.2b.

### 5.3.3.2 Determination of the Number of Data Points

When the contaminant is present in background, Equation 5-2 is used with the WRS test:

#### *Equation 5-2*

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2} (1.2)$$

When the contaminant is not present in background, Equation 5-3 is used with the Sign test:

#### *Equation 5-3*

$$N = \left( \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(\text{Sign } p - 0.5)^2} \right) (1.2)$$

Where:

$Z_{1-\alpha}$	=	Type I decision error level
$Z_{1-\beta}$	=	Type II decision error level
$P_r$	=	random measurement probability
$Sign\ p$	=	random measurement probability
(1.2)	=	20% increase in number of samples over the minimum

During the data assessment phase, the 20 percent increase of samples is omitted for statistical purposes. The number of data points will be presented in the TSP(s).

#### **5.3.4 Error Control**

Actions to minimize errors will be instituted during the data collection phase of the surveys. Qualified radiation survey personnel will perform the survey and record the data. Automated recording of survey data will be used where possible to minimize errors. Data transcribing is an activity where errors may arise. To minimize data errors for manual surveys, experienced personnel will record and transcribe data.

Standard applicable quality assurance and QC measures will be implemented to control error. These measures can be found in the standard operating procedures (SOP) located in Attachment 4.

The ongoing on-site analyses and evaluation of survey results provide a verification check for errors, which will be corrected if detected.

A knowledgeable individual who is not involved in the direct data collection process (e.g., SPM) will review the survey data on a daily basis. This will ensure an ongoing independent review for consistency of survey data collected.

### **5.4 ASSESSMENT OF SURVEY RESULTS**

A preliminary evaluation of the data set will be conducted to better understand the structure of the data and thereby identify appropriate approaches and limitations for utilization. For non-FSSs, this may be merely identifying areas of elevated contamination or reviewing the mean, median, and standard deviation of the data set. FSS evaluations include, but are not limited to, reviewing quality assurance reports, calculating statistical quantities, and graphing the data.

#### **5.4.1 Scoping and Characterization Surveys**

Basic statistical quantities (mean, maximum, standard deviation) will be calculated from the data collected. When a reference area is surveyed, the same quantities will be calculated. The focus of the data assessments will normally be the comparison of the survey data to the DCGL for the building/area. If all measurements are less than the DCGL, then the data will be used in the FSSs, where possible. Measurements above the DCGL will be assessed for further action.

### 5.4.2 Remedial Action Support Surveys

The focus of these data assessments will also be the comparison of the survey data to the DCGL for the building/area. If all measurements are less than the DCGL, then the remedial action can be declared complete and an FSS performed. Otherwise, measurements above the DCGL will be identified for continued remedial action and/or additional surveys.

### 5.4.3 Final Status Surveys

When determining compliance with FSS goals, the survey data are examined. Compliance tests are summarized as follows:

- Compare the largest measurement to the DCGL (net of background, if present in background). If all measurements are lower than the release limits (net of background, if present in background), no statistical test is necessary.
- Compare the average measurement to the DCGL (net of background, if present in background).
- Use the appropriate statistical test to determine if the survey data exceed the release limits, if necessary.
- If scan measurements are above the DCGL, then a fixed measurement will be taken to confirm the elevated reading. If the elevated reading is confirmed, then the unit would fail.

When multiple nuclides are present, each with an individual DCGL, they will be assessed in accordance with the methods described in [Section 6.2](#).

This Management Plan will use an analysis structure incorporating three possible common statistical procedures, as well as conventional qualitative and semi-quantitative comparisons for FSS data. The statistical tests are only applied to measurements made at fixed locations. The tests are:

- **Sign test** – The Sign test is a one-sample, nonparametric test that can be used to evaluate compliance with the release limit. The Sign test is the recommended compliance evaluation procedure when the contaminant(s) under evaluation are not present at significant levels in background. Any one of the individual samples (each individual survey unit is a “sample” in this context) or any combination can be compared to the release limit with the Sign test. For example, each of the Class 1 survey units could be pooled for an overall building comparison to the release limits rather than comparing an individual survey unit to the release limit.
- **Wilcoxon Rank-Sum test** – The WRS test is a two-sample, nonparametric procedure that can be used to evaluate compliance when the contaminant is present in background.

The WRS test can be used as a two-sample test to compare medians between samples (contamination concentration measured in reference background materials versus the same parameter measured in site investigative materials) when either or both sampling distributions deviate significantly from normal.

- **Normal means test** – This is the traditional two-sample t-test based on the central limit theorem (i.e., normality). It can be used to assess compliance, derive confidence intervals, and compare between samples (mean removable surface contamination concentration in one survey unit versus the same parameter measured in another survey unit) when both sample distributions are normal or do not deviate appreciably from normality.

Both scan and fixed measurements are subject to the elevated measurement comparison. The result of this comparison is not conclusive as to whether the survey unit meets or exceeds the release criterion, but is a flag or trigger for further investigation. This comparison is described in [Section 6.1](#).

## **5.5 DECISION MAKING**

### **5.5.1 Scoping and Characterization Surveys**

For a scoping survey, the decision rule is, “If the survey results meet the criteria defined in the TSPs, then design and perform an optimized FSS. If the survey results do not meet the criteria defined in the TSPs, then design and perform an optimized characterization survey.” In practice, most scoping surveys will be tested against DCGLs. If no contamination above the DCGL is found, then the survey data will be used in an FSS Report for determination of suitability for unconditional release. If contamination is found, then a characterization survey would be performed.

For a characterization survey, the decision rule is, “If the survey results meet the criteria defined in the TSPs, then design and perform an optimized FSS. If the survey results do not meet the criteria defined in the TSPs, then perform remedial action.” If no contamination above the DCGL is found, then the survey data would be used in an FSS.

### **5.5.2 Remedial Action Support Surveys**

The decision rule is, “If the survey results indicate that the remediation is complete (as defined in the TSPs), then design and perform an optimized FSS. If the survey results indicate that the remediation is incomplete, then reevaluate the remedial alternative and continue remediation if necessary.”

### **5.5.3 Final Status Surveys**

The results of the statistical testing of the data set for each survey unit will be used to evaluate whether to accept or reject the null hypothesis. Using the MARSSIM ([DoD et al. 2000](#)) Scenario

A methodology, the null hypothesis is stated as “the residual activity in the survey unit exceeds the release criterion.” Thus, in order to pass the survey unit (that is, release the area), the null hypothesis must be rejected. The objective of FSSs will be to demonstrate that residual radioactivity levels meet the release criterion. In demonstrating that the objective is met, the null hypothesis ( $H_0$ ) is tested that residual contamination exceeds the release criterion; the alternative hypothesis ( $H_a$ ) is then tested that residual contamination meets the release criterion.

To validate the use of a test, an evaluation will be made to determine that the data are consistent with the underlying assumptions made for the statistical procedure. Assumptions that can be made in the survey design are:

- The sample sizes determined for the tests are sufficient to achieve the DQO set for the Type I and Type II error.
- The data from the reference area or survey unit consist of independent samples from each distribution.
- The reference area and survey unit data distribution are similar, except for a possible shift in the medians.
- Whether the data represent a normal or asymmetric distribution.

Certain departures from these assumptions may be acceptable when given the actual data and other information about the study. One of the primary advantages of the nonparametric test is that it involves fewer assumptions about the data than the parametric test.

Scenario B methodology as defined in NUREG-1505 ([NRC 1997a](#)) may be used with concurrence from the RASO. If Scenario B is used, specific details will be listed in the TSP as a deviation or exception to the Management Plan.

## 6.0 RELEASE CRITERIA AND INVESTIGATION LEVELS

The release criteria for buildings, structures, material, and land areas at NAS JRB Willow Grove are listed in [Table 6-1](#). Release criteria for equipment and material are taken from Atomic Energy Commission (AEC) Regulatory Guide 1.86 ([AEC 1974](#)). Criteria for structures (surfaces) are also taken from Regulatory Guide 1.86. Release criteria for soils are based on values presented in Nuclear Regulatory Commission document NUREG-1757, Consolidated Decommissioning Guidance ([NRC 2006](#)), whose limits are deemed in compliance with the 25 mrem/y unrestricted dose limit in 10CFR20.1402. Listed values were developed by scaling the NUREG-1757 values to 15 mrem/y unrestricted dose. Release criteria for water have been derived from Radionuclides Notice of Data Availability Technical Document ([EPA 2000](#)) Table III, which compared the federal drinking water standards from the 1976 and 1991 Maximum Contaminant Levels. This value reflects the most conservative limit.

Release criteria organized by survey type are as follows:

- A remedial action support survey will use the release criteria for equipment, material, structures, and soil.
- An FSS will use all the release criteria in [Table 6-1](#), and criteria for scanning surveys known as DCGLs for elevated measurement comparison ( $DCGL_{EMC}$ ), discussed below.

### 6.1 ASSESSING SMALL AREAS OF ELEVATED ACTIVITY

Using guidance from MARSSIM ([DoD et al. 2000](#)), systematic measurements and sampling, in conjunction with surface scanning, are used to obtain adequate assurance that small areas of elevated radioactivity will satisfy the release criterion for small areas. Under RASO direction, this procedure may be implemented for survey units classified as Class 1.

The  $DCGL_W$  is the average concentration across the site that is equivalent to the release criterion, based on dose or risk. The general assumption is that the concentrations of the radionuclides in the source are homogeneous. The degree to which any single localized area can be elevated above the average, assuming the average is at the  $DCGL_W$ , and not invalidate the homogeneous assumption is characterized by the small area criteria ( $DCGL_{EMC}$ ).

Values for the  $DCGL_{EMC}$  are obtained by modifying the  $DCGL_W$  using an area factor that accounts for the difference in area and the resulting change in dose or risk. The area factor is the magnitude by which the concentration within the small area of elevated activity can exceed the  $DCGL_W$  while maintaining compliance with the release criterion. The area factor takes into consideration how a smaller area would affect the dose or risk.

The first step in the process is to assess the scan minimum detectable concentration (MDC); this process is described in [Section 7.2](#). The next step is to determine the “required” scan MDC. The

“required” scan MDC is the product of the  $DCGL_W$  and the area factor (also known as the  $DCGL_{EMC}$ ). This can be calculated using Equation 6-1:

**Equation 6-1**

$$\text{“required” Scan MDC} = DCGL_{EMC} = (DCGL_W) \times (\text{Area Factor})$$

The area factor is obtained from dose modeling using RESRAD or RESRAD-BUILD and is determined based on the size of the area bounded by the sample size in the survey unit. This bounded area ( $a'$ ) is simply the survey unit area (in  $m^2$ ) divided by the number of samples determined in [Section 5.3.3](#). Equation 6-2 is used to derive the size of the area:

**Equation 6-2**

$$a' = \text{Survey Unit Area (in } m^2) / \text{number of samples}$$

The “actual” scan MDC is then compared to the “required” scan MDC. If the “actual” scan MDC is less than the “required” scan MDC, then no additional samples are required. However, if the “actual” scan MDC is greater than the “required” scan MDC, an increase in the number of samples taken may be required. To determine if there is an increase in sample size, the area factor is determined using Equation 6-3:

**Equation 6-3**

$$\text{Area Factor} = (\text{“actual” Scan MDC}) / (DCGL_W)$$

A table of possible area factors is determined by taking the ratio of doses established by using the most current version of RESRAD for outdoor areas or RESRAD-BUILD for structures. For each radionuclide of concern, all exposure pathways are calculated assuming a concentration of radioactive contamination at the release criteria.

The area of contamination in RESRAD defaults to 10,000  $m^2$ . Other than changing the area (i.e., 1, 3, 10, 30, 100, 300, 1,000, or 3,000  $m^2$ ), the RESRAD exposure pathways remain constant. A table of area factors is then computed by taking the ratio of the dose or risk per unit concentration generated by RESRAD for the 10,000  $m^2$  to that generated for the other areas listed. If the DCGL for residual radioactivity distributed over 10,000  $m^2$  is multiplied by this value, the resulting concentration distributed over the specified smaller area delivers the same calculated dose.

Indoor area factors are calculated in a similar manner using the most current version of RESRAD-BUILD. The area of contamination in RESRAD-BUILD defaults to 36  $m^2$ . The other areas to be compared to this value are 1, 4, 9, 16, and 25  $m^2$ . Removable surface contamination

is assumed to be 20 percent. No other changes to exposure pathways are to be made between iterations when calculating a table of values.

This area factor is then used to determine the new area bounded by samples  $a'$  by logarithmically interpolating from a generated table of possible area factors using Equation 6-4 below, and solving for  $a'$ :

**Equation 6-4**

$$\ln(a') = \frac{\ln\left(\frac{y}{z}\right) \cdot \ln\left(\frac{AF_x}{AF_z}\right)}{\ln\left(\frac{AF_y}{AF_z}\right)} + \ln(z)$$

Where:

- $y$  = size of area with lower area factor than area factor determined
- $z$  = size of area with higher area factor than area factor determined
- $AF_x$  = area factor determined
- $AF_y$  = area factor of area  $y$
- $AF_z$  = area factor of area  $z$

Substituting the new bounded area  $a'$  into Equation 6-5 provides the increased number of samples required, if any:

**Equation 6-5**

$$\text{Additional number of samples required} = \text{Survey Unit Area (in } m^2) / (a')$$

The additional number of samples required, in addition to the number required for a particular statistical test from [Section 5.3.3](#), will form the total number of samples required for a particular survey unit when using elevated measurement comparisons. This new total number of samples required will then be applied to the systematic sampling pattern described in [Section 4.4](#) to determine the grid spacing.

## 6.2 ASSESSING MULTIPLE RADIONUCLIDES

When multiple radionuclides are present, either the more conservative of the individual DCGLs or a combined DCGL will be used, as directed by the RASO. A combined DCGL is calculated using Equation 6-6:

### Equation 6-6

$$\text{Combined DCGL} = \frac{1}{\frac{f_1}{\text{DCGL}_1} + \frac{f_2}{\text{DCGL}_2} + \dots + \frac{f_n}{\text{DCGL}_n}}$$

Where  $f_n$  is the anticipated fraction of each radionuclide versus the total, and  $\text{DCGL}_n$  is the DCGL for each radionuclide present, the sum of  $f_1, f_2, f_n$  equals one.

#### 6.2.1 DCGL<sub>w</sub> for Multiple Radionuclides

As stated in MARSSIM (DoD et al. 2000) the  $\text{DCGL}_w$ , when using multiple radionuclides, is established by definition at 1.0. The unity rule, represented in the expression below (Equation 6-7), is satisfied when the radionuclide mixture yields a combined fractional concentration limit that is less than or equal to one. Statistical tests will be used to prove that the total sum of all radionuclides does not exceed the applicable release criterion.

#### 6.2.2 Determination of LBGR for Multiple Radionuclides

The LBGR is the net median concentration of the contaminant in the survey unit. Since this value is unknown, MARSSIM (DoD et al. 2000) suggests using a value for the LBGR of half the DCGL during planning purposes. However, once the median concentration activity in the survey unit is established, this value is used as a ratio to the lowest DCGL for the decay method to determine the LBGR. Equation 6-7, taken from MARSSIM, gives the method used to determine the LBGR:

### Equation 6-7

$$\text{LBGR} = \frac{C_1}{\text{DCGL}_1} + \frac{C_2}{\text{DCGL}_2} + \frac{C_2}{\text{DCGL}_2} + \dots + \frac{C_i}{\text{DCGL}_i} \leq 1$$

Where:

$C_i$  = median concentration of radionuclide “i”

$\text{DCGL}_i$  = DCGL of radionuclide “i”

#### 6.2.3 Determination of Standard Deviation for Multiple Radionuclides

There is no estimate of the standard deviation of the contaminant in a survey unit, especially if no contaminant is initially expected or if concentrations of radionuclides are spatially unrelated. Therefore,  $\sigma$  is assigned the value of the standard deviation of the adjusted measurement values in the survey unit as shown in Equation 6-8 from Section 6.2.3 of Decommissioning Health Physics (Abelquist 2001):

**Equation 6-8**

$$\sigma = \sqrt{\left(\frac{\sigma_{C1}}{DCGL_1}\right)^2 + \left(\frac{\sigma_{C2}}{DCGL_2}\right)^2 + \dots + \left(\frac{\sigma_{Ci}}{DCGL_i}\right)^2}$$

Where:

$\sigma_{Ci}$  = standard deviation from radionuclide “i”  
 $DCGL_i$  = DCGL of radionuclide “i”

### 6.3 CONVERTING DCGL UNITS

At times, it may be necessary to convert the DCGL from picocuries per gram (pCi/g) to counts per minute (cpm) in order to calculate the number of samples required in a given survey unit. To perform this conversion, an arbitrary concentration of the radionuclide is divided by the associated exposure rate produced by the concentration (as identified in Section 7.2.9. The resulting number is then divided by the average net cpm per microrentgens per hour ( $\mu R/hr$ ) for the detector being used. Once the number is derived, the release criterion is divided by this number, as shown in Equation 6-9 below:

**Equation 6-9**

$$cpm = \frac{DCGL}{DCGL_{AC} / M * DCGL_{AC} / \mu Rcpm}$$

Where:

$DCGL$  = release criterion (pCi/g)  
 $DCGL_{AC}$  = arbitrary concentration of radionuclide (pCi/g)  
 $M$  = exposure rate calculated by MicroShield™ (Grove Engineering 1996)  
 $\mu Rcpm$  = counts per minute per  $\mu R/hr$  for the detector

### 6.4 INVESTIGATION LEVELS

Investigation levels are specific levels of radioactivity used to indicate when additional investigation may be necessary. Investigation levels also serve as a QC check. For example, in addition to indicating potential contamination, a measurement that exceeds the investigation level may indicate that the survey unit has been improperly classified or may indicate a failing instrument.

When determining an investigation level using a statistical-based parameter (e.g., standard deviation), the following may be considered: survey objectives, underlying radionuclide

distributions (e.g., normal, log normal, nonparametric), data population descriptors (e.g., standard deviation, mean, median), and prior survey and historical information.

When an investigation level is exceeded, the measurement will be confirmed to ensure that the initial measurement/sample actually exceeds the particular investigation level. This will involve taking further measurements to confirm the initial result, and as appropriate, to quantify the area of elevated residual radioactivity.

#### **6.4.1 Investigation Levels for Gamma Radiation Surveys**

For gamma surveys the investigation level will normally be established at the reference area mean +  $3\sigma$ , where  $\sigma$  is the standard deviation of the gamma readings in the reference area. Multiple reference areas may be used, as necessary. Other investigation levels may be implemented with prior RASO concurrence. Investigation levels will be provided in the TSP.

#### **6.4.2 Investigation Levels for Alpha and Beta Radiation Surveys**

For alpha and beta surveys, the investigation level will be the DCGL<sub>W</sub> or a statistical-based parameter, if used. Investigation levels are provided in the TSPs.

## **7.0 INSTRUMENTATION**

Instruments will be selected that are suitable for the physical and environmental conditions at the site. The instruments and measurement methods selected will be able to detect the radionuclide of concern or radiation types of interest, and are, in relation to the survey or analytical technique, capable of measuring levels sufficient to support the DQOs. [Table 7-1](#) identifies the instrumentation resources available to support the survey objectives.

### **7.1 FIELD SURVEY INSTRUMENTS**

Portable survey instruments will be used to perform measurements in the field. [Table 7-1](#) lists the types of portable survey equipment expected to be used during survey activities at NAS JRB Willow Grove.

#### **7.1.1 Calibration**

Portable survey instrument calibration will be completed on an annual frequency. Instrument calibration will also be performed after repairs or modifications have been performed on the instrument. The instrument will be calibrated in accordance with the manufacturer's recommended method.

#### **7.1.2 Daily Performance**

Prior to use of the portable survey instruments, calibration verification, physical inspection, battery check, and source-response check will be performed per SOP 007, Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use.

All portable survey instruments will have a current calibration label that will be verified daily prior to use of the instrument.

Physical inspection of the portable survey instrument will include:

- General physical condition of the instrument and detector prior to each use
- Knobs, buttons, cables, connectors
- Meter movements/displays
- Instrument cases
- Probe/probe window(s)
- Other physical properties that may affect the proper operation of the instrument or detector

Any portable survey instrument or detector having a questionable physical condition will not be used until the problems have been corrected.

A battery check will be performed to ensure that sufficient voltage is being supplied to the detector and instrument circuitry for proper operation. This check will be performed in accordance with the instrument's operations manual.

The instrument will be exposed to the appropriate (alpha, beta, gamma) check source to verify that the instrument response is within the plus or minus percent range determined during the initial response check.

The results of the daily operation checks discussed above will be documented. Instruments that do not pass the daily operation checks will be removed from service until all deficiencies have been corrected.

### **7.1.3 Instruments for Surface Scan Surveys for Alpha Activity**

Scan surveys for alpha radiation will be performed using a Surface Contamination Monitor (SCM) , Ludlum Model 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 (or equivalent).

### **7.1.4 Instruments for Surface Scan Surveys for Beta Activity**

Scan surveys for beta radiation will be performed using a SCM, Ludlum Model 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 (or equivalent).

### **7.1.5 Instruments for Direct Measurement Static Surveys for Alpha Activity**

Static surveys for alpha radiation will be performed using a Ludlum Model 2221, 2241, 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 (or equivalent).

### **7.1.6 Instruments for Direct Measurement Static Surveys for Beta Activity**

Static surveys for beta radiation will be performed using a Ludlum Model 2221, 2241, 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 (or equivalent).

### **7.1.7 Instruments for Scan Surveys for Gamma Activity**

Scan surveys for gamma radiation will be performed using a Ludlum Model 2241, 2350-1 data logger (or equivalent) equipped with a Ludlum Model 44-10 2-inch by 2-inch sodium iodide (NaI) scintillation detector (or equivalent) or RASO approved towed array gamma survey system.

### **7.1.8 Instruments for Direct Measurement Static Surveys for Gamma Activity**

Direct measurement static surveys for gamma radiation will be performed using a Ludlum Model 2241, 2350-1 (or equivalent) equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI scintillation detector (or equivalent).

### 7.1.9 Instruments for Direct Measurement Surveys for Beta Gamma Activity

Direct measurement surveys for beta and gamma radiation will be performed using Ludlum Model 3, 12, 177, 2221, 2241 or equivalent, with a model 44-9 Geiger Mueller pancake probe (or equivalent). This instrument combination is normally used for routine surveys associated with operational aspects of decommissioning activities such as monitoring personnel and equipment exiting a radiologically controlled area.

### 7.1.10 Instrument for Exposure Rate Surveys

Exposure rate surveys are conducted with use of a Ludlum Model 19 MicroR meter (or equivalent). Compatible with anticipated exposure rates, the instrument is equipped with an internally mounted 1-inch by 1-inch NaI scintillation detector that is integral to the meter housing.

## 7.2 INSTRUMENTATION EQUATIONS

The following equations are used to calculate efficiencies, MDCs, and minimum detectable count rates (MDCRs).

### 7.2.1 Instrument Efficiency

The instrument efficiency ( $\varepsilon_i$ ) is defined as the ratio between the net count rate, in cpm, of the instrument and the surface emission rate of the calibration source for a specified geometry. The surface emission rate is the  $2\pi$  particle fluence that is affected by both the attenuation and backscatter of the radiation emitted from the calibration source.

Equation 7-1 will be used to calculate the instrument efficiency in counts per particle, although efficiency is typically reported as having no units or unitless:

#### *Equation 7-1*

$$\varepsilon_i = \frac{R_{S+B} - R_B}{q_{2\pi} \left( \frac{W_A}{S_A} \right)}$$

Where:

- $R_{S+B}$  = the gross count rate of the calibration measurement (cpm)
- $R_B$  = the background count rate in cpm
- $q_{2\pi}$  = surface emission rate of the calibration source (National Institute of Standards and Technology [NIST] traceable) in particles per minute
- $W_A$  = active area of the detector window (square centimeters [ $\text{cm}^2$ ])
- $S_A$  = area of the source ( $\text{cm}^2$ )

The instrument efficiency procured from the instrument calibration service is determined by obtaining static counts with the detector over a calibration source that has a NIST-traceable

surface emission rate. The  $2\pi$  particle fluence rate is corrected for decay. Then the surface emission rate of the source must be corrected for the area subtended by the probe. Factors that can also affect instrument efficiency are discussed below:

- Efficiency Check Sources. Efficiency check sources that emit alpha or beta radiation with energies similar to those expected from the contaminant in the field (similar to the expected radionuclide[s] of concern) will be selected.
- Source Geometry Factors. Instrument efficiency will usually be determined with an efficiency check source equal to or greater than the area of the probe. If a source smaller than the probe used, no conversion factor is applied to the MDC. Conversion factors are applied if the source is larger than the probe.
- Source-to-Detector Distance. The detector efficiency will be calculated at a source-to-detector distance the same as the detector-to-surface distance used in the field.

### 7.2.2 Surface Activity Measurements

Surveillance measurements are used to quantify surface activity levels on concrete and other building surfaces. International Organization for Standardization (ISO) 7503-1 (ISO 1988), NUREG/CR-1507 (NRC 1997b), and Selection and Use of Portable Radiological Survey Instruments for Performing In-Situ Radiological Assessments in Support of Decommissioning (American Society for Testing and Materials 1998) are used as technical guidance to ensure accuracy in the measurement of surface activity.

Equation 7-1a is used to calculate the surface activity in units of disintegrations per minute (dpm) per 100 cm<sup>2</sup>:

**Equation 7-1a**

$$A_S = \frac{R_{S+B} - R_B}{\epsilon_i \epsilon_s \frac{W_A}{100 \text{ cm}^2}}$$

Where:

$A_S$	=	total surface activity (dpm/100 cm <sup>2</sup> )
$R_{S+B}$	=	the gross count rate of the measurement in cpm
$R_B$	=	the background count rate in cpm
$\epsilon_i$	=	the instrument efficiency
$\epsilon_s$	=	the contaminated surface efficiency
$W_A$	=	the area of the detector window (cm <sup>2</sup> )

### 7.2.3 Count Detection Probability for Alpha Scans ( $\leq 126\text{-cm}^2$ Probe)

Scanning for alpha emitters differs significantly from scanning for beta and gamma emitters in that the expected background response of most alpha detectors is very close to zero. The following sections cover scanning for alpha emitters.

Since the time a contaminated area is under the probe varies and the background count rate of some alpha instruments is less than 1 cpm, it is not reasonable to determine a fixed MDC for scanning. Instead, it is more practical to determine the probability of detecting an area of contamination at a predetermined DCGL for given scan rates.

For alpha survey instrumentation with backgrounds ranging from less than 1 to 3 cpm, a single count provides a surveyor sufficient cause to stop and investigate further. Assuming this to be true, the probability of detecting given levels of alpha surface contamination can be calculated by use of Poisson summation statistics.

Given a known scan rate and a surface contamination release limit, the probability of detecting a single count while passing over the contaminated area is given by Equation 7-2:

#### ***Equation 7-2***

$$P(n \geq 1) = 1 - e^{-\frac{GE+B(d)}{60v}}$$

Where:

$P(n \geq 1)$	=	probability of observing a single count
$G$	=	contamination activity (dpm)
$E$	=	detector efficiency ( $4\pi$ )
$B$	=	background count rate (cpm)
$d$	=	width of detector in direction of scan (cm)
$v$	=	scan speed (centimeters per second [cm/s])

Once a count is recorded and the guideline level of contamination is present, the surveyor should stop and wait until the probability of getting another count is at least 90 percent. This time interval can be calculated by Equation 7-3:

#### ***Equation 7-3***

$$t = \frac{13,800}{CAE}$$

Where:

$t$	=	time period for static count(s)
$C$	=	contamination guideline (dpm/100 $\text{cm}^2$ )
$A$	=	physical probe area ( $\text{cm}^2$ )

$E$  = detector efficiency ( $4\pi$ )

#### 7.2.4 Count Detection Probability for Alpha Scans (582-cm<sup>2</sup> Probe)

The larger (582 cm<sup>2</sup>) gas-proportional detectors have background count rates on the order of 5 to 10 cpm, and a single count will not cause a surveyor to investigate further. A counting period long enough to establish that a single count indicates an elevated contamination level would be prohibitively inefficient. For these types of instruments, the surveyor usually will need to get at least two counts while passing over the source area before stopping for further investigation.

Assuming this to be a valid assumption, the probability of getting two or more counts can be calculated by Equation 7-4:

**Equation 7-4**

$$P(n \geq 2) = 1 - \left[ 1 + \frac{(GE + B)t}{60} \right] \left[ e^{\frac{-(GE+B)t}{60}} \right]$$

Where:

$P(n \geq 2)$  = probability of getting two or more counts during the time interval  $t$   
 $t$  = time interval (s)  
 $G$  = source activity (dpm)  
 $E$  = detector efficiency ( $4\pi$ )  
 $B$  = background count rate (cpm)

#### 7.2.5 Scan detection for Alpha Scans (Surface Contamination Monitor)

The SCM is an automated scan and record system using a Position Sensitive Proportional Counter (PSPC). Scan speed is controlled by means of a DC motor. System scan speed is also computer recorded during a survey. Surface-to-detector distance is maintained by using a rigid detector mount and setting the distance prior to conducting a survey. All counts recorded by the system are computer recorded. The pulses received by the PSPC are “binned” in 5 centimeters wide areas of the detector, and are logged every 5 centimeters of system travel as determined by a precision wheel encoder feeding the computer. The result is that data is recorded in 25 cm<sup>2</sup> areas over the entire surface that is surveyed. A square meter area will have 400 individual data points recorded. As a result, the SCM scan sensitivity can be determined a priori in a fashion similar to beta survey instruments. The actual system sensitivity, or a posteriori MDC, can be determined from graphical analysis of the thousands of data points generated from even small surveys.

The low release criteria for Ra-226 requires that particle detection theory, as described in Section 6.7.2.2 and Appendix J of MARSSIM (NRC 2000), be employed to determine an instrument’s ability to detect radioactivity. To achieve the necessary detection, the SCM can be operated in a

recount mode, utilizing two separate detectors hard linked to one other. Counts on a “bin” by “bin” basis on the first detector can be compared with counts in the identical “bins” on the second detector when the second detector was over the same area as the first. For each 100 cm<sup>2</sup> area, lower thresholds can be set that require counts above the threshold on both detectors to occur prior to requiring follow-up on that area. The process greatly reduces the number of false positives, the major issue when performing alpha surveys.

To achieve 95 percent probability of detection of a 100 dpm  $\alpha$  emitting radionuclide, the system will be operated at 0.5 inch per second. The 100 dpm source will result in at least two counts in a 100 cm<sup>2</sup> area on both the primary and recount detector more than 95 percent of the time. The probability of getting two or more counts in the same 100 cm<sup>2</sup> area due to background has a low probability, less than 0.01 percent, because of the low  $\alpha$  background associated with the SCM. Background values typically are less than 1 cpm per 100 cm<sup>2</sup> area.

The probability of detecting two counts due to a source is given by Equation 7-4 from above.

Since the detectors associated with the SCM are manufactured to the same specifications, the efficiency of each detector is similar. Therefore, the probability of obtaining 2 or more counts on each detector as they traverse the same 100 dpm source is the square of the probability for a single detector.

For areas with higher alpha backgrounds, calculations can continue to establish the probability of obtaining 3, or 4 counts from a 100 dpm source. A higher background will increase the probability of detecting a source since background is not subtracted. Using a threshold of 3 or 4 may be necessary to reduce the number of Type I errors to a manageable level while still maintaining a reasonable probability of detecting the 100 dpm source.

#### **7.2.6 Minimal Detectable Count Rate and Minimum Detectable Concentration for Beta Scans**

The minimum detectable number of net source counts in the scan interval can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in  $d'$ ) as shown in Equation 7-5:

***Equation 7-5***

$$MDCR = d' \sqrt{b_i} \left( \frac{60}{i} \right)$$

Where:

- $d'$  = index of sensitivity ( $\alpha$  and  $\beta$  errors [performance criteria])
- $b_i$  = number of background counts in scan time interval (count)

$i$  = scan or observation interval(s)

The required rate of true positives will be 95 percent, and the false positives will be 5 percent. From Table 6.5 of MARSSIM (DoD et al. 2000), the value of  $d'$ , representing this performance goal, is 3.28.

The minimum detectable number of net source counts in the interval is given by  $S_i$ . Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (as reflected in  $d'$ ), as shown in Equation 7-5a:

**Equation 7-5a**

$$S_i = d' \sqrt{b_i}$$

The scan MDC is determined from the MDCR by applying conversion factors that account for detector and surface characteristics and surveyor efficiency. As discussed below, the MDCR accounts for the background level, performance criteria ( $d'$ ), and observation interval. The observation interval during scanning is the actual time that the detector can respond to the contamination source. This interval depends on the scan speed, detector size in the direction of the scan, and area of elevated activity.

The scan MDC for structure surfaces is calculated using Equation 7-6:

**Equation 7-6**

$$\text{Scan MDC} = \frac{\text{MDCR}}{\sqrt{p} \varepsilon_i \varepsilon_s \frac{W_A}{100 \text{ cm}^2}}$$

Where:

MDCR is discussed above

$p$  = surveyor efficiency factor

$\varepsilon_i$  = instrument efficiency (count per particle)

$\varepsilon_s$  = contaminated surface efficiency (particle per disintegration)

$W_A$  = area of the detector window ( $\text{cm}^2$ ) [Defaults to  $100 \text{ cm}^2$  for probes greater than  $100 \text{ cm}^2$ ]

### 7.2.7 MDC for Static Alpha and Beta Counts

The static MDC is the level of radioactivity practically achievable by the overall measurement process. Equation 7-7 is used to calculate instrument MDC in dpm per  $100 \text{ cm}^2$  when the background and sample are counted for the same time intervals:

**Equation 7-7**

$$MDC = \frac{3 + 4.65\sqrt{R_B T_B}}{\varepsilon_s \varepsilon_i \frac{W_A}{100} T_B}$$

Where:

- $R_B$  = background count rate (cpm)
- $T_B$  = background counting time (minute [min])
- $\varepsilon_i$  = instrument efficiency (counts per particle)
- $\varepsilon_s$  = contaminated surface efficiency (particles per disintegration)
- $W_A$  = active area of the detector window (cm<sup>2</sup>) [Defaults to 100 cm<sup>2</sup> for probes greater than 100 cm<sup>2</sup>]

In Equation 7-7,  $W_A$  is the size of the “active” area of the detector window. If the area of the detector window (cm<sup>2</sup>) is less than 100 cm<sup>2</sup>, it is necessary to convert the detector response to units of dpm per 100 cm<sup>2</sup>.

If the background and sample are counted for different time intervals, Equation 7-8 is used to calculate the MDC in dpm per 100 cm<sup>2</sup>:

**Equation 7-8**

$$MDC = \frac{3 + 3.29\sqrt{R_B T_{S+B} \left(1 + \frac{T_{S+B}}{T_B}\right)}}{\varepsilon_i \varepsilon_s \frac{W_A}{100 \text{ cm}^2} T_{S+B}}$$

Where:

- $R_B$  = background count rate (cpm)
- $T_B$  = background counting time (min)
- $T_{S+B}$  = sample counting time (min)
- $\varepsilon_i$  = instrument efficiency (counts per particle)
- $\varepsilon_s$  = contaminated surface efficiency (particles per disintegration)
- $W_A$  = active area of the detector window (cm<sup>2</sup>) [Defaults to 100 cm<sup>2</sup> for probes greater than 100 cm<sup>2</sup>]

### **7.2.8 Surface Efficiency ( $\varepsilon_s$ ) for Surface Activity Measurements**

The surface efficiency term in the preceding equations is used to determine the  $4\pi$  total efficiency for a particular surface and condition. Suitable values are based on the radiation and radiation energy, and are primarily impacted by the backscatter and self-absorption characteristics of the surface on which the contamination exists in the field. Backscatter is most affected by the energy of the radiation and the density of the surface material. Self-absorption

characteristics or attenuation are also a function of the radiation's energy and surface condition. Surfaces typically encountered in the field include concrete, asphalt, wood, drywall, plaster, carpet, and metal. Surface conditions include both physical effects, such as scabbled concrete, and the effect of surface coatings: dust, paint, rust, water, and oil.

In the absence of experimentally determined surface efficiencies, ISO-7503-1 (ISO 1988) and NUREG-1507 (NRC 1997b) provide conservative recommendations for surface efficiencies. ISO-7503-1 recommends a surface efficiency of 0.5 for maximum beta energies exceeding 0.4 megaelectron volt (MeV) and to use a surface efficiency of 0.25 for beta energies between 0.15 and 0.4 MeV and for alpha emitters (ISO 1988; NRC 1997b). NUREG-1507 provides surface efficiencies based on studies performed for the NRC. In general, NUREG-1507 indicates that the ISO rule of thumb for surface efficiencies is conservative, particularly for beta-emitting radionuclides with end-point energies between 0.25 MeV and 0.4 MeV. A surface efficiency of 0.25 will be used for alpha and beta emitters at NAS JRB Willow Grove.

### 7.2.9 MDC for Gamma Scans of Surface Areas

The scan MDC (in pCi/g) for land areas is based on the area of elevated activity, depth of contamination, and the radionuclide (energy and yield of gamma emissions). To establish the scan MDC, the relationship between the detector's net count rate to net exposure rate must be established first. This is accomplished by determining the MDCR using Equation 7-5 and then applying a surveyor efficiency factor  $p$  to get the  $MDCR_{Surveyor}$  as show below in Equation 7-9:

#### Equation 7-9

$$MDCR_{Surveyor} = MDCR / \sqrt{p}$$

The  $MDCR_{Surveyor}$  is then converted into the corresponding minimum detectable exposure rate (MDER) by use of a calibration constant specific to the detector being used and the radionuclide of concern. For example, when used with the Ludlum Model 2350-1, the calibration records for the Ludlum Model 44-10 2-inch by 2-inch NaI scintillation detector provide a calibration constant that can be used to determine the ratio of cpm to  $\mu R/hr$ , as shown in Equation 7-10 below:

#### Equation 7-10

$$MDER (\mu R / hr) = \frac{MDCR_{Surveyor} * 6 \times 10^7}{cc}$$

Where:

$$\begin{aligned}
 MDCR_{Surveyor} &= \text{as calculated in Equation 7-9} \\
 6 \times 10^7 &= \text{a conversion factor accounting for differences in time and activity units } ([\mu\text{R-min}]/[\text{R-hr}]) \\
 cc &= \text{calibration constant } ([\text{counts}]/[\text{R}])
 \end{aligned}$$

Next, the relationship between the radionuclide concentration and exposure rate is established. This is accomplished by modeling (using MicroShield) to determine the net exposure rate produced by the radionuclide at a distance above the ground. The factors considered in modeling include:

- The dose point above the surface
- The density of material in grams per cubic centimeter
- DCGL of the radionuclide of concern in pCi/g
- The depth of detection for the DCGL
- The circular dimension of the cylindrical area of detector capability ( $\text{m}^2$ )

The concentration of the radionuclide of concern (Scan MDC) necessary to yield the MDER may be calculated by taking the ratio of the MDER to the exposure rate calculated by MicroShield or Monte Carlo *N*-Particle code, as shown in Equation 7-11 below:

**Equation 7-11**

$$\text{Scan MDC} (p\text{Ci} / g) = \frac{\text{DCGL} (p\text{Ci} / g) * \text{MDER} (\mu\text{R} / \text{hr})}{\text{Microshield Exposure Rate} (\mu\text{R} / \text{hr})}$$

### 7.2.10 Minimum Detectable Count Rate for Static Gamma Counts

For gamma surveys, MDCR, rather than MDC, is calculated in cpm. If the background and sample are counted for the time intervals, Equation 7-12 is used to calculate the MDCR:

**Equation 7-12**

$$MDCR = \frac{3 + 4.65\sqrt{R_B T_B}}{T_B}$$

Where:

$$\begin{aligned}
 3 + 4.65 &= \text{constant factor provided by MARSSIM} \\
 R_B &= \text{background count rate (cpm)} \\
 T_B &= \text{background counting time (min)}
 \end{aligned}$$

TSPs will not normally be designed to use different background and sample count times for gamma scan surveys; any deviation from this requires RASO approval, and notation in the TSP and final reports as an exception to the Management Plan. If the background and sample are counted for different time intervals, Equation 7-13 is used to calculate the MDC:

**Equation 7-13**

$$MDC = \frac{3 + 3.29 \sqrt{R_B \cdot T_{S+B} \cdot \left(1 + \frac{T_{S+B}}{T_B}\right)}}{T_{S+B}}$$

Where:

- $3 + 3.29$  = constant factor provided by MARSSIM
- $R_B$  = background count rate (cpm)
- $T_{S+B}$  = background counting time (min)
- $T_B$  = background counting time (min)

### **7.3 LABORATORY INSTRUMENTS**

Laboratory equipment will be used to analyze samples collected in the field. Worksheet 23 of the SAP (Attachment 3) of the SAP lists the types of laboratory equipment expected to be used at NAS JRB Willow Grove.

#### **7.3.1 Quality Assurance Checks**

Quality assurance checks shall be performed on laboratory instrumentation to ensure proper operation and to maintain calibration. The quality checks shall be documented, reviewed, and maintained. Data trends outside the tolerance limits shall be investigated to determine the cause and potential effect on measurement results.

#### **7.3.2 Gross Alpha/Beta Loose Surface Contamination Surveys**

Swipe samples will be processed using a Ludlum Model 2929 scaler or equivalent. Data are reported in units of cpm per 100 cm<sup>2</sup>.

#### **7.3.3 Gamma Spectroscopy**

Gamma spectroscopy will be performed in accordance with the SAP by a Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) accredited laboratory. All results are reported in pCi/g, picocuries per milliliter (pCi/mL), or picocuries per liter (pCi/L), depending on the media analyzed. The off-site Laboratory Manager reviews all data results, including energy spectrums, for quality assurance and to verify count integration, efficiency, and background corrections, as well as the identification of overlapping peaks. If there is any

question on the analysis results, the sample is reprocessed and possibly counted for a longer interval.

#### **7.3.4 Liquid Scintillation Analysis**

Liquid scintillation counting will be performed in accordance with the SAP by a Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) accredited laboratory. The results are identified in dpm or pCi/g and grouped by energy.

#### **7.3.5 Total Strontium/Strontium-90 Analysis**

Total strontium analysis will be performed in accordance with the SAP by a DoD ELAP accredited laboratory. If the total strontium release criterion is exceeded for any sample, strontium 90 (Sr-90) analysis will be performed in accordance with the SAP by a DoD ELAP accredited laboratory. The results of <sup>90</sup>Sr analysis typically are reported in pCi/g, pCi/mL, or pCi/L, depending on the media analyzed.

#### **7.3.6 Alpha Spectroscopy Analysis**

Analysis of alpha-emitting radioisotopes will be performed in accordance with the SAP by a DoD ELAP accredited laboratory. The results of alpha spectroscopy analysis are reported in pCi/g, pCi/mL, or pCi/L, depending on the media analyzed.

## **8.0 SURVEY IMPLEMENTATION**

This section discusses the types of surveys and their implementation in the field with a focus on the methods for conducting each type of survey. The survey procedures described in this section will be performed in accordance with approved SOPs or work instructions. Additional survey implementation details will be identified in each TSP.

### **8.1 REFERENCE (BACKGROUND) AREAS**

An average background level will be determined by performing measurements at systematic or random locations within the designated background area. The detector probe will be held approximately 10 centimeters (4 inches) from the surface area for gamma radiation and 0.25 inch from the surface area for alpha/beta radiation. Instrumentation will be allowed to stabilize before background readings are taken. The average of the larger of the readings or the method detection limit or minimum detectable activity (MDA) reported by the laboratory for all of the readings taken will determine the background. Background scan ranges, swipes, and exposure rates will also be collected for reference data. In some cases, solid samples will need to be collected in the background area for comparative analyses of specific survey units. The same survey methodology and instruments used to collect the background data will be used to perform measurements within survey units.

### **8.2 SCAN SURVEYS**

Scan surveys are an integral part of survey programs conducted to determine contamination levels. The surveys are an evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation. It will be used to identify areas that may require additional survey measurements.

#### **8.2.1 Scan Surveys for Alpha/Beta Radiation**

Surface scan surveys for alpha and beta radiation will be performed by moving the detector over the surface being surveyed at a rate of approximately 0.5 inch per second. The detector will be held within 0.635 centimeter (0.25 inch) over the surface being surveyed.

#### **8.2.2 Scan Surveys for Gamma Radiation**

Scan measurements are obtained by traversing a path at a maximum speed (scan rate) of approximately 0.5 meter per second and slowly moving the detector assembly in a serpentine (S-shaped) pattern, while maintaining the detector approximately 10 centimeters (4 inches) above the area being surveyed.

### **8.3 STATIC SURVEYS**

Static contamination surveys are used to determine contamination levels on surface areas for scoping, characterization, and/or release surveys. The surveys are an evaluation technique

performed by holding a detection device over a surface for a specified time at a set distance to detect radiation.

### **8.3.1 Static Surveys for Alpha and Beta Surface Activity**

Direct measurements will be conducted with the detector within 0.635 centimeter (0.25 inch) above the surface. Count time for conducting the measurement will be dependent upon the radionuclide of concern.

### **8.3.2 Static Surveys for Gamma Radiation**

Static gamma measurements require positioning the detector assembly approximately 10 centimeters (4 inches) above the surface and completing a stationary 60-second survey.

## **8.4 EXPOSURE RATE MEASUREMENTS**

Exposure rate surveys are performed to measure ambient gamma radiation levels. These measurements are obtained by holding the detection device at the required distance from the surface being surveyed. Instrumentation will be allowed to stabilize before taking the measurement.

## **8.5 SWIPE SAMPLE MEASUREMENTS**

Swipe sampling will be performed to assess the presence of radioactive contamination that is readily removed from a surface. Swipe samples will be taken to evaluate the presence of alpha and beta surface activity. As called for in individual TSPs, swipe samples may be collected to evaluate tritium contamination. The procedures for collecting swipe samples are discussed in the SAP.

## **8.6 SURVEY AND SAMPLE LOCATIONS**

Static measurements, swipe samples, exposure rate measurements, and media samples will be taken from the same predetermined locations within each survey unit to obtain data for use in FSSs. [Section 4.4](#), Reference Coordinate Systems, and [Section 6.1](#), Assessing Small Areas of Elevated Activity, provide further discussion of survey and sample locations for FSSs. Scan and static measurement locations for equipment and material surveys are given in TSPs and/or; SOPs 006, Radiation and Contamination Surveys; 012, Release of Materials and Equipment from Radiologically Controlled Areas; and other work instructions. [Table 1-1](#) lists each of the Tt field SOPs developed for performing radiological work at NAS JRB Willow Grove. Copies of the SOPs as well as work instructions are available in the Tt offices, when mobilized, at NAS JRB Willow Grove and can be provided to the DON and regulatory agencies for review upon request.

## **8.7 EQUIPMENT AND MATERIAL SURVEYS**

Equipment and materials surveys will be performed in accordance with SOPs. [Table 6-1](#) lists acceptable levels of contamination based on the AEC Regulatory Guide 1.86 limits. In the event

that survey results indicate levels of contamination exceeding the limits listed in [Table 6-1](#) (for surfaces), appropriate decontamination methods will be performed using methods described in these SOP 016, Decontamination of Equipment and Tools.

## **8.8 PERSONNEL SURVEYS**

Properly trained staff will perform personnel surveys in a predesignated low-background area before leaving a radiologically controlled area, as specified in the RWP or when deemed necessary by the RCT. Personnel who are not qualified to administer a self-survey will be monitored by a qualified technician. Personnel surveys will be performed using the appropriate survey methods described above and in accordance with appropriate SOP 006, Radiation and Contamination Surveys.

## **8.9 MEDIA SAMPLING**

Various samples may be collected for radiological analysis, including soil, water, brick, porcelain, wood, and others. The SAP will describe the methods for collecting samples, sample numbering, sample labeling, sample shipment, and completion of the associated chain-of-custody and other required documentation.

## **8.10 AIR SAMPLING**

As specified in the RWP, airborne activity monitoring (continuous or grab samples) and engineering controls will be necessary during the course of work. To control occupational exposures, establish PPE, and determine respiratory-protection requirements, monitoring and trending for airborne radioactive material will be performed as necessary. Engineered controls will be implemented if required to maintain airborne concentrations below 10 percent of the applicable derived air concentration (DAC) value for the radionuclides of concern ([Table 8-1](#)).

If, during the course of work, an airborne concentration exceeds 10 percent of the DAC, ongoing activities will cease and the affected location will be posted until the source of the airborne concentration is eliminated and levels are confirmed to be below 10 percent of the DAC. Air monitoring will be performed using the methods described in SOP 008, Air Sampling and Sample Analysis.

## **8.11 GLOBAL POSITIONING SYSTEM MEASUREMENTS**

As specified in TSPs, Global Positioning System (GPS) units may be used while performing outdoor area field surveys. For example, during an outdoor gamma scan survey, a GPS unit may be carried adjacent to the gamma detector. The GPS output will be logged along with the gamma count rates, so that each gamma reading will have an associated location point. After the survey, gamma data may be color coded and plotted on a survey map.

In addition, outdoor survey units may be mapped by walking the perimeter with a GPS unit. Once the outline is digitized, static reading locations for that survey unit can be generated in latitude and longitude, using Visual Sample Plan software ([Gilbert et al. 2001](#)). These points can be located using the GPS unit followed by the collection of static readings and samples, as appropriate.

## **9.0 DECONTAMINATION, DISMANTLING, AND DISPOSITION**

Decontamination, dismantling, and disposition activities will be performed, as identified in a TSP, as part of radiological remedial action activities performed at NAS JRB Willow Grove. Decontamination is the removal, by chemical or physical means, of radioactive material from various types of internal and external surfaces including equipment, materials, components, systems, and structures. Dismantling is the removal, as applicable, of furniture, equipment, and walls or similar structural outworks and components for the purpose of permanently breaking down, removing, and eliminating such materials. This would also include conducting work in open land areas to support the removal of contaminated material or devices. To assess the extent and type of contaminants identified during the course of ongoing fieldwork, various remedial activity support surveys will be necessary.

### **9.1 DECONTAMINATION**

To support ongoing work at NAS JRB Willow Grove, decontamination of materials, equipment, and structures may be necessary. There are numerous decontamination methods available for use. If practical, manual decontamination methods should be used. Abrasive methods may be necessary if areas of fixed contamination are identified. Chemical decontamination can also be advantageous by using detergents for nonporous surfaces with contamination present. Chemicals should be selected for decontamination that will minimize the creation of mixed waste.

Decontamination activities will be conducted using SOP 016, Decontamination of Equipment and Tools and per TSP and subsequent RASO approval.

### **9.2 DISMANTLING AND REMEDIATION**

To support the release of buildings, structures, equipment, materials, and land areas, remedial support activities will need to be conducted. These activities include, but are not limited to, soil removal, and dismantling, disassembling, and/or removal of various systems, components, and structures. The following is a list of expected remedial support activities that may be performed at NAS JRB Willow Grove:

- Piping and associated pumping system removal
- Ventilation system removal
- Equipment, furniture, and material removal, including floor coverings, floor tiles and mastic.
- Soil, asphalt, or concrete removal
- Building demolition
- Structure removal

Specific control methods and more detailed information will be provided in the TSP.

### **9.3 DISPOSITION**

Disposition is the methodology of identifying the radiological status of equipment, materials, and structures for its end use. Disposition will be conducted after the decontamination and/or dismantling activities have been completed. This will include the following key elements:

- Control of equipment and materials
- Free release
- Decontaminate for free release
- Off-site disposal, per DODEA LLRW broker, if necessary

Controlling equipment and materials is essential to ensure that contaminated items are not used in uncontrolled areas to prevent the inadvertent spread of contamination. If decontamination methods are unsuccessful, some materials and equipment may be stored for future use in radiologically controlled areas. If it is not feasible or cost-effective to control contaminated equipment and materials, they will be disposed of off-site in accordance with RASO guidance.

## 10.0 RADIOACTIVE MATERIALS MANAGEMENT

Planned site activities could potentially involve the presence of radioactive materials. Activities involving the presence of radioactive material, including handling, storage, packaging, will be performed under the requirements of NRC license #29-31396-01, issued to Tetra Tech, Inc. A copy of the license is included as [Attachment 1](#). Copies of supporting procedures are included as [Attachment 4](#). The activities will be conducted by personnel who are trained and qualified to apply management and control measures as required by regulatory agencies. The license requires that the provisions of 10 CFR Part 19 and 10 CFR Part 20 be implemented for activities involving radioactive materials.

The RSOR or the SPM will delegate the daily operating responsibility for related activities with the use of defined directives that comply with applicable regulatory requirements. Actions necessary to carry out related decisions and policy include:

- Specific oversight of radioactive materials that result from site activities
- Acting as a primary point of contact for site-specific activities involving radioactive materials
- Establishing administrative controls to manage radioactive materials according to regulatory requirements
- Acting as a primary point of contact with the NRC or Agreement States on radioactive materials present such as point sources, soil contaminants, naturally occurring radioactive material (NORM)
- Coordinating activities with subcontractors performing activities under this management plan

### 10.1 MANAGING RADIOACTIVE MATERIALS

The day-to-day management of radioactive material is governed by NRC License #29-31396-01 ([Attachment 1](#)) which requires compliance with the requirements of 10 CFR Part 19 and 10 CFR Part 20. Existing materials that require the implementation of radioactive materials management include:

- Sealed radioactive sources used for radiation-detection instrument checks
- Devices and contaminants from past operations at NAS JRB Willow Grove
- Control of radioactive and mixed waste generated during current site operations

Activities involving radioactive materials will be controlled by SOPs. An SOP will be implemented if field conditions meet the procedural requirements. Those SOPs may include SOP 002, SOP 004, SOP 008, SOP 010, SOP 011, SOP 012, and SOP 022. If required by SOP 002, a RWP will be issued. The RWP will establish radiation protection requirements for

performing specific tasks. The requirements may include dosimetry, air sampling, protective clothing requirements and limitations on the performance of the work. Radioactive material will be managed by the RSOR or designee. Off-site organizations and contractors who plan to use radioactive materials in support of project activities must obtain approval. Approval can be obtained by directing a request, in writing, through the RSOR or designee. Requests must include:

- A detailed description of proposed radioactive material use
- A copy of the appropriate NRC or Agreement State License with a completed NRC Form 241, Navy Radioactive Material Permit (NRMP) or exemption, if the material is licensed
- Name and address of the responsible local representative and contact information
- A copy of contract documentation describing the work to be done and inclusive dates
- Documentation acknowledging that the RSOR or designated appointee can perform periodic checks to ensure that the user is complying with applicable requirements

## **10.2 RADIOACTIVE MATERIAL HANDLING**

There should be no contact with radioactive material or exposure to ionizing radiation where an expected benefit is not realized. Exposures should be ALARA and consistent with technology, cost, and operational requirements.

### **10.2.1 Limitations**

Designees responsible for the control of radioactive materials are required to limit its accessibility and use. Material management policies (that performed by the contractor and its subcontractors) require an inventory accountability process. Clearly defined radiological safety requirements shall be established for (1) operating, changing, and repairing systems containing, or designed to operate with radioactive material; and (2) control of waste materials resulting from investigative processes.

### **10.2.2 Authorizations**

Work involving the handling and storage of radioactive materials will be performed under NRC License #29-31396-01 which requires compliance with the requirements of 10CFR19 and 10CFR20 and with authorization for such work from the PRSO.

In order to minimize unauthorized access to or removal of radioactive materials, application of appropriate security-protection measures will be exercised (for example, combination or key lock safes for source storage, conex boxes with padlocked doors for sample storage, or “clam shell” casings for drums). Licensed radioactive sources and devices, as well as non-exempt quantities of radioactive materials in non-permitted sources, must be routinely inventoried and documented

as such. Identification of locations where radioactive materials are present will be accomplished with the use of conspicuous posting compliant with Title 10 CFR Part 20.

The SOP will be periodically assessed for accuracy and applicability by the RSOR or designee appointee to ensure that necessary requirements are in place to manage radioactive material. The degree of required management is dependent on the quantity and type of material on hand, where the material is generated, and the location and configuration of available storage.

Only pre-authorized areas will be used to store radioactive materials. These areas will be selected with concurrence from the Navy. Security measures for these areas will be coordinated with the Caretaker Site Office.

Radioactive material handling activities must be performed in a manner to ensure that:

- Access to areas or rooms is restricted where radioactive materials are known to be present
- Surveys of areas where sealed radioactive materials are stored are completed at least weekly
- Surveys of areas where unsealed radioactive materials are used are completed according to a RWP.

## **11.0 DOCUMENTATION AND RECORDS MANAGEMENT**

The purpose of this section is to define standards for the maintenance and retention of radiological records. Radiological records provide historical data, document radiological conditions, and record personnel exposure.

Project electronic data will be downloaded from its collection device (such as laptop computers and data loggers) on a daily basis. At the conclusion of each day's survey activities, electronic data collected that day will be backed up to appropriate removable media (for example, compact disk, zip disk, or equivalent) and the backup will be removed from the site. The backup will not be stored in the same building in which the original project electronic data is stored.

Sample collection, field measurements, and laboratory data will be recorded both electronically and on paper, to the extent practicable. Data and information recorded on paper will be recorded using indelible ink. Both electronic and paper records of field-generated data will be reviewed by the RSOR or a designee knowledgeable in the measurement method for completeness, consistency, and accuracy. Data manually transposed to paper from electronic data collection devices will be compared to the original data sets to ensure consistency and to resolve noted discrepancies. Electronic copies of original electronic data sets will be preserved on a nonmagnetic retrievable data storage device. No data reduction, filtering, or manipulation will be performed on the original electronic versions of data sets.

Project data will be recorded in project data logbooks or on approved forms. Multiple survey teams may use individual project data logbooks during the field effort. Sample collection forms, direct measurement forms, and photographic log sheets will be provided as needed to sampling teams in the field. All actions taken to review, approve, transfer, copy, duplicate, backup, store or secure project data will be noted in a project data logbook.

Project data logbooks, individual team member logbooks, field data forms, COC forms, and copies of all electronic data files will be filled out and collected at completion of fieldwork associated with each building or land area.

The data will be entered and reviewed for accuracy and completeness by the RSOR, SPM or designee. Following review, the RSOR, SPM or designee will certify accuracy of information in the project data logbooks.

Data logbooks and approved forms are considered legal records. Logbooks will be permanently bound and the pages will be numbered. Pages may not be removed from logbooks under any circumstances. Logbook entries will be in ink, legible, factual, detailed, and complete and will be signed and dated by the individuals making the entries. Completed forms will be in ink, legible, detailed, factual, and signed and dated by the individual completing the form. If a mistake is made in a log or on a form, placing a single line through the erroneous entry and

initialing and dating the correction will denote the error. Under no circumstances will any previously entered information be completely obliterated. Use of whiteout in data logbooks or on forms is not permitted for any reason. Project documents will be transferred to Navy personnel at the end of the project to be maintained as specified in the radioactive materials license.

Photographs of sample collection and direct measurement activities taken during the field operations will be documented in a project logbook or using approved forms. Electronic photos will be saved as Joint Photographic Experts Group (JPEG) format files. Descriptions of photographs will include the building and room number or area description; direction photographer is facing, and any measurement location information relevant to the photograph to correlate location.

## **11.1 REQUIREMENTS**

Records resulting from implementation of this Management Plan shall meet the quality standards as outlined herein. All records must be retrievable. Working copies of records used for reference will be stored separately from the original.

Completed records awaiting transfer to long-term storage shall be stored in an appropriate manner to minimize loss and damage that could result from exposure to weather, fire, or other conditions.

Principal personnel who create, review, and approve radiological records must sign and date the record.

## **11.2 DOCUMENT QUALITY STANDARDS**

Records shall be legible and completed with an indelible ink that provides reproducible and legible copies. Records shall be dated and contain a verifiable signature of the originator. Errors shall be corrected by marking a single line through the error and by initialing and dating the correction. Radiological records shall not be corrected using an opaque substance. Shorthand or nonstandardized terms may not be used.

To ensure traceability, each record shall clearly indicate:

- Identification of the facility
- Specific location
- Function and process
- Date
- Document number (if applicable)

The quantities used in records shall be clearly indicated in standard units (curie, rad, rem, dpm, becquerel), including multiples and subdivisions of these units.

### **11.3 DOCUMENTATION**

The four types of documentation that will be maintained and assessed are field operation records, laboratory records, data handling records, and work support documents. The majority of the data produced will be entered into the electronic data management system to produce quality data for inclusion in reports, documents, and presentations.

#### **11.3.1 Data Management System**

Supportable and definitive data must be produced and managed to achieve the removal action objectives. The Tt team developed a unique “cradle-to-grave” data management system that seamlessly integrates all phases of the radiological and construction work process from initial survey, excavation, remediation, and FSS activities through backfill of survey units and site restoration. Acquiring, evaluating, and managing data are the principal tasks involved in every aspect of the removal action activities. The resulting survey data are easily uploaded to the NEDD-NIRIS database.

#### **11.3.2 Field Operation Records**

The information contained in field operation records will document overall field operations and may consist of the following:

- Field measurement records – At a minimum, this documentation will identify the names of the persons conducting the activity, measurement identification, measurement locations, measurement results, maps and diagrams, equipment, and unusual observations. Data record forms, bound field notebooks, and electronic data loggers will be used to record raw data and make references to prescribed procedures and changes in planned activities.
- Sample tracking records – These records will be documented as identified in the SAP.
- QC records – QC records will be prepared as indicated in the SAP.
- Personnel files – Personnel files record the names and training certificates of the staff collecting data and will be maintained in accordance SAP.
- Deficiency and problem identification reports – The project SPM documents any work not performed in accordance with management plan, TSPs or procedural requirements on a Nonconformance Report (NCR). The NCR will detail the nonconforming condition, the recommended corrective action(s) and the disposition of the corrective action(s). The NCR shall remain open until the nonconforming condition has been satisfactorily resolved and verified by the project SPM.

### **11.3.3 Data Handling Records**

Data-handling records document protocols used in data reduction, verification, and validation (as applicable). Data reduction involves data transformation processes such as converting raw data into reportable quantities and units, using significant figures, and calculating measurement uncertainties. Data verification involves reviewing reports of data entered into the electronic data management systems by the appropriate supervisory personnel knowledgeable of and with access to the original data to verify data transcription accuracy in accordance with SOPs. Data comparison and evaluation will be done on radiological samples as discussed in the SAP. Record copies of surveys, sampling, and analytical data (and their supporting data) will be protected and maintained in project record files. [Table 1-1](#) lists each of the current Tt field SOPs developed for use at NAS JRB Willow Grove. Copies of these SOPs as well as work instructions are available in the Tt offices, when mobilized, at NAS JRB Willow Grove and can be provided to the DON and regulatory agencies upon request.

### **11.3.4 Work Support Documents**

Work support documents may include RWPs, TSPs, reports, and work instructions that will be prepared, reviewed, and approved.

## 12.0 REFERENCES

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## **TABLES**

**TABLE 1-1**  
**NAVAL AIR STATION JOINT RESERVE BASE WILLOW GROVE**  
**STANDARD OPERATING PROCEDURES<sup>a</sup>**

<b>Standard Operating Procedures</b>	
<b>SOP Number</b>	<b>SOP Title</b>
SOP 002	Issue and Use of Radiation Work Permits
SOP 004	Project Dosimetry
SOP 006	Radiation and Contamination Surveys
SOP 007	Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use
SOP 008	Air Sampling and Sample Analysis
SOP 009	Sampling Procedures for Radiological Surveys
SOP 010	Radiologically Restricted Area Posting and Access Control
SOP 011	Control of Radioactive Material
SOP 012	Release of Materials and Equipment from Radiologically Controlled Areas
SOP 016	Decontamination of Equipment and Tools
SOP 017	Radiological Respiratory Protection
SOP 022	Radiological Protective Clothing Selection, Monitoring, and Decontamination
SOP 023	Source Control
SOP 024	Occurrence Reporting
RP-OP-017	Operation of the Ludlum Model 2929 Dual Scaler
RP-OP-025	Operation of the Ludlum Model 2221
RP-OP-026	Operation of the Ludlum Model 19
SCM-OPS-01	Position Sensitive Proportional Counters Purging
SCM-OPS-02	Position Sensitive Proportional Counters Plateau Determination
SCM-OPS-03	Position Sensitive Proportional Counters Position Calibration
SCM-OPS-04	Encoder Calibration
SCM-OPS-05	Position Sensitive Proportional Counters Efficiency Calibration
SCM-OPS-06	Position Sensitive Proportional Counters Quality Assurance
SCM-SETUP-01	Position Sensitive Proportional Counters Repair
SCM-SETUP-02	Hardware Setup
SCM-SETUP-03	Quality Assurance Testing of SCM

<sup>a</sup> The most current version of each controlled SOP and Work Instruction is available in the Tt offices at NAS JRB Willow Grove and can be provided to the DON and regulatory agencies upon request.

DON Department of the Navy

SCM Surface Contamination Monitor

SOP Standard Operating Procedure

Tt Tetra Tech

**TABLE 4-1**  
**SURVEY UNIT SIZE**

Area Classification	Survey Unit Size
Class 1 Structure	Up to 100 m <sup>2</sup> floor area
Class 1 Land area	Up to 2,000 m <sup>2</sup>
Class 2 Structure	100 to 1,000 m <sup>2</sup>
Class 2 Land area	2,000 to 10,000 m <sup>2</sup>
Class 3 Structure	No limit
Class 3 Land area	No limit

*Abbreviations and Acronyms:*  
m<sup>2</sup> – square meter

**TABLE 5-1**  
**DATA LIFE CYCLE USED TO SUPPORT THE**  
**RADIATION SURVEY AND SITE INVESTIGATION PROCESS**

<b>RSSI Process</b>	<b>Data Life Cycle</b>	<b>Phases</b>	<b>MARSSIM Guidance</b>
Site Identification	N/A	N/A	Provides information on identifying potential radiation sites (Section 3.3) <sup>a</sup>
Historical Site Assessment	Historical Site Assessment Data Life Cycle	Plan Implement Assess Decide	Provides information on collecting and assessing existing site data (Sections 3.4 through 3.9) and potential sources of information (Appendix G)
Scoping Survey	Scoping Data Life Cycle	Plan Implement Assess Decide	Discusses the purpose and general approach for performing scoping surveys, especially as sources of information when planning FSSs (Section 5.2)
Characterization Survey	Characterization Data Life Cycle	Plan Implement Assess Decide	Discusses the purpose and general approach for performing characterization surveys, especially as sources of information when planning FSSs (Section 5.3)
Remedial Action Support Survey	Remedial Action Data Life Cycle	Plan Implement Assess Decide	Discusses the purpose and general approach for performing remedial action support surveys, especially as sources of information when planning FSSs (Section 5.4)
FSS	Final Status Data Life Cycle	Plan Implement Assess Decide	Provides detailed guidance for planning FSSs (Chapter 4 and Section 5.5), selecting measurement techniques (Chapters 6 and 7, and Appendix H), and assessing the data collected during FSSs (Chapters 8 and 9)

**Notes:**

a Section numbers refer to chapters in MARSSIM (DoD et al. 2000).

Abbreviations and Acronyms:

FSS – Final Status Survey

MARSSIM – Multi-Agency Radiation Survey and Site Investigation Manual

N/A – not applicable

RSSI – Radiation Survey and Site Investigation

**TABLE 5-2  
SURVEY STRATEGIES**

Survey Type	Minimum Survey Requirement	Sampling and/or Direct Measurements <sup>a</sup>	Minimum Scanning Requirements	Static Measurements	Surface Scans	Exposure Rates	Swipes <sup>b</sup>	Media Samples <sup>c</sup>	General Operational Surveys <sup>d</sup>
Scoping <sup>e</sup>	N/A	Random and Additional Biased	Judgmental	X	X	X	I	O	
Characterization <sup>e</sup>	N/A	Systematic and Additional Biased	Judgmental	X	X	X	I	O	
Remedial Action Support	N/A	Random and Biased	Judgmental						X
Final Status	Class 1	Systematic with Random Start	100% Coverage	X	X	X	I	O	
	Class 2	Systematic with Random Start	50% Coverage	X	X	X	I	O	
	Class 3	Random	25% Coverage	X	X	X	I	O	

**Notes:**

I = indoor surveys; O = outdoor surveys; X = both

a Additional locations will be chosen based on history and the judgment of the RSOR. The minimum number of sample points will be calculated as in [Section 5.3.3](#).

b In addition to the swipes taken at each randomly or systematically determined sampling point, swipe sampling will be performed on floor drains, exhaust fans, work benches, sinks, and other suspect locations.

c Indoor locations may be chosen based on scanning results and the judgment of the RSOR.

d General operation surveys may include static measurements, surface samples, exposure rates, swipes, and media samples.

e Reference the HRA for NAS JRB Willow Grove ([Tetra Tech 2012](#)).

**Abbreviations and Acronyms:**

HRA – Historical Radiological Assessment

N/A – not applicable

RSOR – Radiation Safety Officer Representative

**TABLE 6-1**  
**RELEASE CRITERIA**

Radionuclides	CAS Number	SURFACES	SOILS <sup>b</sup>	WATER <sup>d</sup>	Laboratory Specific	
		Structures, M&E, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	pCi/g <sup>c</sup>	pCi/L	QL pCi/g	MDA pCi/g
Radium-226	13982-63-3	100	1.0	5 <sup>e</sup>	0.7	0.33
Total Strontium	7440-24-6	1,000	1.02	8	0.32	0.32
Tritium (H-3)	10028-17-8	5,000	66	20,000	10 pCi/sample	10 pCi/sample
Uranium-238	7440-61-1	5,000	8.4	30	0.5	0.5

**Notes:**

Criteria for other nuclides will be listed in TSPs, if needed.

a These limits are based on AEC Regulatory Guide 1.86 ([USAEC 1974](#)). Values indicate the measured value above background as determined from the reference area. Limits for removable surface activity are 20 percent of these values.

b These limits are based on Nuclear Regulatory Commission document NUREG-1757, Consolidated Decommissioning Guidance ([NRC 2006](#)), whose limits are deemed in compliance with the 25 mrem/y unrestricted dose limit in 10CFR20.1402. Listed values were developed by scaling the NUREG-1757 values to 15 mrem/y unrestricted dose.

c Criteria is above background for those radionuclides found in background soils.

d Release criteria for water have been derived from *Radionuclides Notice of Data Availability Technical Document* ([EPA 2000](#)) Table III, which compared the federal drinking water standards from the 1976 and 1991 Maximum Contaminant Levels. This value reflects the most conservative limit.

e Limit is for total Radium Concentration.

**Abbreviations and Acronyms:**

pCi/g      picocurie per gram  
pCi/L      picocuries per liter  
dpm        disintegration per minute

**TABLE 7-1**  
**PORTABLE SURVEY INSTRUMENTS**

Measurement/ Technique	Type of Instrument			Typical Background	Typical Total Efficiency (%)	Typical Minimum Detectable Concentration
	Detector	Detector Size and Dimension	Meter Description			
Surface Alpha Scan	Gas Proportional Ludlum 43-68	126 cm <sup>2</sup> 7.9 cm x 16 cm	Ludlum 2221, 2241, or data logger 2350-1, 2360	0-2 cpm $\alpha$	~ 25 $\alpha$	0.969 probability of detection (Note 1)
Surface Alpha Scan	Position Sensitive Proportional Counter	100 cm <sup>2</sup> 10 cm x 10 cm	Surface Contamination Monitor	1 cpm/100 cm <sup>2</sup>	~ 35 $\alpha$	0.998 probability of detection (Note 2)
Surface Beta Scan	Gas Proportional Ludlum 43-68	126 cm <sup>2</sup> 7.9 cm x 16 cm	Ludlum 2221, 2241, or data logger 2350-1, 2360	150-250 cpm	~ 25 $\beta$	~2,000 dpm/100 cm <sup>2</sup> (Note 3)
Surface Beta Scan	Position Sensitive Proportional Counter	100 cm <sup>2</sup> 10 cm x 10 cm	Surface Contamination Monitor	350-400 cpm/ 100 cm <sup>2</sup>	~ 25 $\beta$	~2,100 dpm/100 cm <sup>2</sup> (Note 3)
Static Alpha Measurement	Gas Proportional Ludlum 43-68	126 cm <sup>2</sup> 7.9 cm x 16 cm	Ludlum 2221, 2241, or data logger 2350-1, 2360	0-2 cpm $\alpha$	~ 25 $\alpha$	~ 80 dpm/100 cm <sup>2</sup> (Note 4)
Static Alpha Measurement	Position Sensitive Proportional Counter	100 cm <sup>2</sup> 10 cm x 10 cm	Surface Contamination Monitor	1 cpm/100 cm <sup>2</sup>	~ 35 $\alpha$	~ 60 dpm/100 cm <sup>2</sup> (Note 4)
Static Beta Measurement	Gas Proportional Ludlum 43-68	126 cm <sup>2</sup> 7.9 cm x 16 cm	Ludlum 2221, 2241, or data logger 2350-1, 2360	150-250 cpm	~ 25 $\beta$	~1100 dpm/100 cm <sup>2</sup> (Note 5)
Static Beta Measurement	Position Sensitive Proportional Counter	100 cm <sup>2</sup> 10 cm x 10 cm	Surface Contamination Monitor	350-400 cpm/ 100 cm <sup>2</sup>	~ 25 $\beta$	~1250 dpm/100 cm <sup>2</sup> (Note 5)
Static Beta Measurement	Geiger-Mueller Model 44-9	15 cm <sup>2</sup> 4.37 cm diameter	Ludlum 3, 12, 177, 2221 or 2241	50-100 cpm	~ 10 $\beta$	350 dpm/100 cm <sup>2</sup>

**TABLE 7-1 (CONTINUED)**  
**PORTABLE SURVEY INSTRUMENTS**

Measurement/ Technique	Type of Instrument			Typical Background	Typical Total Efficiency (%)	Typical Minimum Detectable Concentration
	Detector	Detector Size and Dimension	Meter Description			
Swipe Analyzer	Ludlum 43-10-1 Scintillation Probe	20.3 cm <sup>2</sup> 5.05 cm diameter	Ludlum Model 2929	3 cpm $\alpha$ 80 cpm $\beta$	38% $\alpha$ 26% $\beta$	16 dpm $\alpha$ , 325 dpm $\beta$
Gamma Exposure Rate	Micro R meter Ludlum Model 19	N/A	Sodium Iodide	5 – 7 $\mu$ R/hr	N/A	N/A
Gamma	Ludlum 44-10 NaI (tl) probe	2 in. x 2 in.	Ludlum 2241 or 2360	9750 cpm	N/A	900 cpm/ $\mu$ R/hr

**Notes:**

$\alpha$  Alpha

$\beta$  Beta

cm<sup>2</sup> Centimeters squared

cpm Counts per minute

dpm Disintegrations per minute

mrR/hr millirems per hour

Note 1 Probability of Detection is based on a 100 dpm point source; 0.5 inch/sec scan speed, 1 cpm background, and a detection threshold value of 2 counts per detector width.

Note 2 Probability of Detection is based operation of the SCM in the recount mode (two detectors, as described in [Section 7.2.5](#)), a 100 dpm point source, 0.5 inch/sec scan speed, 1 cpm background, and a detection threshold value of 2 counts per 100 cm<sup>2</sup> area. The Probability of Detection is based on both detectors observing the threshold value or greater in the same 100 cm<sup>2</sup> area.

Note 3 Scan MDC values are based on 95% false negative and 5% false positive at a survey speed of 2 inches per second. The scan MDC is based on typical efficiencies for Cs-137.

Note 4 Alpha Static Measurement MDC is based on a 1 minute count with the 43-68 detector and an 8-second count with the SCM

Note 5 Beta Static Measurement MDC is based on a 1 minute count with the 43-68 detector and an 8-second count with the SCM. The static MDC is based on typical efficiencies for Cs-137

**TABLE 8-1**  
**DERIVED AIR CONCENTRATION**

Radionuclide	Radiation	DAC ( $\mu\text{Ci/mL}$ )	10% DAC ( $\mu\text{Ci/mL}$ )
Radium-226	Alpha ( $\alpha$ )	$3.0 \times 10^{-10}$	$3.0 \times 10^{-11}$
Plutonium-239		$3.0 \times 10^{-12}$	$3.0 \times 10^{-13}$
Thorium-232		$5.0 \times 10^{-13}$	$5.0 \times 10^{-14}$
Strontium-90	Beta ( $\beta^-$ )	$8.0 \times 10^{-9}$	$8.0 \times 10^{-10}$
Tritium-3		$2.0 \times 10^{-5}$	$2.0 \times 10^{-6}$
Cobalt-60	Beta/gamma ( $\beta^-$ , $\gamma$ )	$7.0 \times 10^{-8}$	$7.0 \times 10^{-9}$
Uranium-235		$6.0 \times 10^{-10}$	$6.0 \times 10^{-11}$
Cesium-137		$6.0 \times 10^{-8}$	$6.0 \times 10^{-9}$
Americium-241	Alpha/gamma ( $\alpha$ , $\gamma$ )	$3.0 \times 10^{-12}$	$3.0 \times 10^{-13}$

**Abbreviations and Acronyms:**

$\mu\text{Ci/mL}$  – microcuries per milliliter

CFR – *Code of Federal Regulations*

DAC – derived air concentration (10 CFR 20 Appendix B)

**ATTACHMENT 1**

**TETRA TECH EC, INC. NRC RADIOACTIVE MATERIALS LICENSE,  
29-31396-01**

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION I  
475 ALLENDALE ROAD  
KING OF PRUSSIA, PENNSYLVANIA 19406-1415

March 2, 2010

Docket No. 03038199  
Control No. 144333

License No. 29-31396-01

Philip Bartley  
Vice President, ESQ  
Tetra Tech EC, Inc.  
1000 The American Road  
Morris Plains, NJ 07950

SUBJECT: TETRA TECH EC, INC., NEW LICENSE, CONTROL NO. 144333

Dear Mr. Bartley:

This refers to your request for an NRC license. Enclosed with this letter is the license. Please review the enclosed document carefully and be sure that you understand all conditions. Please be informed that your license is assigned the program code 03219, Decontamination Services. If there are any errors or questions, please notify the U.S. Nuclear Regulatory Commission, Region I Office, Licensing Assistance Team, (610) 337-5239, so that we can provide appropriate corrections and answers.

When submitting future license amendments, please have the document signed by a management representative rather than the Radiation Safety Officer. The NRC views a letter signed by a management representative as indication that management has reviewed the application and concurs in the statements and representations contained therein. In addition, please note that NRC Form 313 requires the applicant, by signature, to verify that the applicant understands that all statements contained in the application are true and correct to the best of the applicant's knowledge. The signatory for the application should be the licensee or a certifying official of the licensee rather than a consultant.

The NRC expects licensees to conduct their programs with meticulous attention to detail and high standards of safety and compliance. Because of the serious consequences to employees and the public that can result from failure to comply with NRC requirements, you must conduct your program according to NRC regulations, the conditions of your NRC license, and the representations made in your application. In particular, note that you must:

1. Operate in accordance with NRC regulations 10 CFR Part 19, "Notices, Instructions and Reports to Workers; Inspections," 10 CFR Part 20, "Standards for Protection Against Radiation," and other applicable regulations.
2. Notify the NRC in writing of any change in mailing address.

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P. Bartley

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3. In accordance with 10 CFR 30.36(d), notify the NRC, promptly, in writing, and request termination of the license
  - a) when you decide to terminate all activities involving materials authorized under the license; or
  - b) if you decide not to acquire or possess and use authorized material.
4. Request and obtain a license amendment before you:
  - a) change Radiation Safety Officers;
  - b) order byproduct material in excess of the amount, or radionuclide, or form different than authorized on the license;
  - c) add or change the areas of use, or addresses of use identified in the license application or on the license; or
  - d) change the name or ownership of your organization.
5. Submit a complete renewal application or termination request at least 30 days before the expiration date of your license. You will receive a reminder notice approximately 90 days before the expiration date. Possession of byproduct material after your license expires is a violation of NRC regulations.

You will be periodically inspected by the NRC. Failure to conduct your program safely and in accordance with NRC regulations, license conditions, and the representations made in your license application and supplemental correspondence with NRC will result in enforcement action against you. This could include issuance of a notice of violation, imposition of a civil penalty, or an order suspending, modifying or revoking your license.

An environmental assessment for this action is not required, since this action is categorically excluded under 10 CFR 51.22(c)(14).

Current NRC regulations and guidance are included on the NRC's website at [www.nrc.gov](http://www.nrc.gov); select **Nuclear Materials; Medical, Academic, and Industrial Uses of Nuclear Material**; then **Regulations, Guidance, and Communications**. You may also obtain these documents by contacting the Government Printing Office (GPO) toll-free at 1-866-512-1800. The GPO is open from 7:00 a.m. to 6:30 p.m. EST, Monday through Friday (except Federal holidays).

P. Bartley

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Thank you for your cooperation.

Sincerely,

A handwritten signature in black ink, appearing to read "Kathy Modes". The signature is fluid and cursive, with the first name "Kathy" and last name "Modes" clearly distinguishable.

Kathy Modes  
Senior Health Physicist  
Decommissioning Branch  
Division of Nuclear Materials Safety

Enclosure:  
License No. 29-31396-01

cc w/enclosure:  
Erik Abkemeier, Radiation Safety Officer

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NRC FORM 374

PAGE 1 OF 6 PAGES

U.S. NUCLEAR REGULATORY COMMISSION

**MATERIALS LICENSE**

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Tetra Tech EC, Inc.	3. License number 29-31396-01
2. 1000 The American Road Morris Plains, New Jersey 07950	4. Expiration date March 31, 2020
	5. Docket No. 030-38199 Reference No. 46-27767-01/03036414

- |  |                                  |  |
|--|----------------------------------|--|
| 6. Byproduct, source, and/or special nuclear material        | 7. Chemical and/or physical form | 8. Maximum amount that licensee may possess at any one time under this license   |
| A. Any byproduct material with atomic numbers 1 through 83   | A. Any                           | A. 100 curies per radionuclide and 100 curies total  |
| B. Any byproduct material with atomic numbers 84 through 103 | B. Any                           | B. 1 curie per radionuclide and 1 curie total  |
| C. Radium 226  | C. Any                           | C. 5 curies total  |
| D. Source Material   | D. Any                           | D. 10,000 kilograms  |
| E. Any Special Nuclear Material                              | E. Any                           | E. Not to exceed 200 grams uranium-233, or 350 grams uranium-235, or 200 grams plutonium, or any combination of these provided the sum of the ratios does not exceed unity |

## 9. Authorized use:

- A. through E. Receipt, storage, use, and/or possession incident to the following activities:
- (1) Decontamination, decommissioning, and remediation of contaminated structures, materials, groundwater, soils and soil-like material;
  - (2) Site characterization;
  - (3) Solidification and treatment of wastes;
  - (4) Packaging for transport;
  - (5) Transport in packages or containers approved for use under the provisions of 10 CFR Part 71, for transfer to licensees authorized to receive the materials, in accordance with the terms and conditions of licenses issued by the NRC or an Agreement States.

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NRC FORM 374A

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## MATERIALS LICENSE SUPPLEMENTARY SHEET

License Number  
29-31396-01

Docket or Reference Number  
030-38199

### CONDITIONS

10. Licensed material may be used only at temporary job sites of the licensee anywhere in the United States where the U.S. Nuclear Regulatory Commission maintains jurisdiction for regulating the use of licensed material, including areas of exclusive Federal jurisdiction within Agreement States.  
  
If the jurisdiction status of a Federal facility within an Agreement State is unknown, the licensee should contact the Federal agency controlling the job site in question to determine whether the proposed job site is an area of exclusive Federal jurisdiction. Authorization for use of radioactive materials at job sites in Agreement States not under exclusive Federal jurisdiction shall be obtained from the appropriate state regulatory agency.
11. Licensed material shall be used by, or under the supervision of, individuals who have received the training described in the letter dated February 22, 2010.
12. The Radiation Safety Officer for this license is Erik Abkemeier.
13. This license does not authorize the use of licensed material at temporary job sites for uses already specifically authorized by the customer's license. If a customer also holds a license issued by the NRC or an Agreement State, the licensee shall establish a written agreement between the licensee and the customer specifying which licensed activities shall be performed under the customer's license and supervision, and which licensed activities shall be performed under the licensee's supervision pursuant to this license. The agreement shall include a commitment by the licensee and customer to ensure safety, and any commitments by the licensee to help the customer clean up the temporary job site if there is an accident. A copy of this agreement shall be included in the notification required by Condition 18.A. of this license.
14. Pursuant to 10 CFR Parts 30.11, 40.14, 70.14, and Condition 10 of this license, the licensee is exempted from the requirements of 10 CFR Parts 30.35, 40.36 and 70.25 to establish decommissioning financial assurance.
15. Except for calibration sources and reference standards, possession of licensed material at each temporary job site shall be limited to material originating from each site. This material must either be transferred to an authorized recipient or remain at the site after activities authorized by this license are completed.
16. Notwithstanding the requirements in 10 CFR Parts 30.32(i), 40.31(j), and 70.22(i), the licensee is not required to establish an emergency plan. Before taking possession of licensed material at a temporary job site in quantities requiring an emergency plan, the licensee shall either:
  - (1) Obtain NRC approval of an evaluation demonstrating that an emergency plan is not required pursuant to 10 CFR Parts 30.32(i), 40.31(j), and 70.22(i); or

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**MATERIALS LICENSE  
SUPPLEMENTARY SHEET**

License Number  
29-31396-01

Docket or Reference Number  
030-38199

- (2) Submit written confirmation to the Regional Administrator, U.S. Nuclear Regulatory Commission, Region I, ATTN: Director, Division of Nuclear Materials Safety, 475 Allendale Road, King of Prussia, Pennsylvania 19406, that the licensee personnel have been trained and will follow the provisions of an existing emergency plan approved by the NRC or an Agreement State for the temporary job site.
17. If approved by the Radiation Safety Officer specifically identified in this license, the licensee may take reasonable action in an emergency that departs from conditions in this license when action is immediately needed to protect public health and safety and no action consistent with all license conditions that can provide adequate or equivalent protection is immediately apparent. The licensee shall notify the NRC before, if practicable, and in any case, immediately after taking such emergency action using reporting procedure specified in 10 CFR Part 30.50(c).
18. A. At least 14 days before initiating activities at a temporary job site, the licensee shall notify, in writing, the Regional Administrator, U.S. Nuclear Regulatory Commission, Region I, ATTN: Director, Division of Nuclear Materials Safety, 475 Allendale Road, King of Prussia, Pennsylvania 19406. The notification shall include the following information:
- (1) Estimated type, quantity, and physical/chemical form(s) of material;
  - (2) Specification of site location;
  - (3) Description of project activities including waste management and disposition;
  - (4) Estimated project start date and duration; and
  - (5) Identification of, and information on how to contact, key project personnel.
- B. Within 30 days of completing activities at each job site location, the licensee shall notify, in writing, the Regional Administrator, U.S. Nuclear Regulatory Commission, Region I, ATTN: Director, Division of Nuclear Materials Safety, 475 Allendale Road, King of Prussia, Pennsylvania 19406, of the temporary job site status and disposition of any licensed material used.
19. The licensee shall maintain records of information important to decommissioning each temporary job site at the applicable job site pursuant to 10 CFR Parts 30.35(g), 40.36(f), and 70.25(g). The records shall be made available to the customer upon request. At the completion of activities at a temporary job site, the licensee shall transfer these records to the customer for retention.
20. The licensee shall not use licensed material in or on human beings.
21. The licensee shall conduct a physical inventory every six months, or at other intervals approved by the U.S. Nuclear Regulatory Commission, to account for all sources and/or devices received and possessed under the license. Records of inventories shall be maintained for 5 years from the date of each inventory and shall include the radionuclides, quantities, manufacturer's name and model numbers, and the date of the inventory.

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**MATERIALS LICENSE  
SUPPLEMENTARY SHEET**

License Number

29-31396-01

Docket or Reference Number

030-38199

22. A. Sealed sources shall be tested for leakage and/or contamination at intervals not to exceed six months or at the intervals specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission under 10 CFR 32.210 or under equivalent regulations of an Agreement State.
- B. Notwithstanding Paragraph A of this Condition, sealed sources designed to primarily emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.
- C. In the absence of a certificate from a transferor indicating that a leak test has been made within the intervals specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission under 10 CFR 32.210 or under equivalent regulations of an Agreement State, prior to the transfer, a sealed source received from another person shall not be put into use until tested and the test results received.
- D. Sealed sources need not be tested if they contain only hydrogen-3; or they contain only a radioactive gas; or the half-life of the isotope is 30 days or less; or they contain not more than 100 microcuries of beta- and/or gamma-emitting material or not more than 10 microcuries of alpha-emitting material.
- E. Sealed sources need not be tested if they are in storage and are not being used; however, when they are removed from storage for use or transferred to another person and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.
- F. The leak test shall be capable of detecting the presence of 0.005 microcurie (185 becquerels) of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie (185 becquerels) or more of removable contamination, a report shall be filed with the U.S. Nuclear Regulatory Commission in accordance with 10 CFR 30.50(c)(2), and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with Commission regulations.
- G. Tests for leakage and/or contamination, including leak test sample collection and analysis, shall be performed by the licensee or by other persons specifically licensed by the U.S. Nuclear Regulatory Commission or an Agreement State to perform such services.
- H. Records of leak test results shall be kept in units of microcuries and shall be maintained for 5 years.
23. Sealed sources or detector cells containing licensed material shall not be opened or sources removed from source holders by the licensee.

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**MATERIALS LICENSE  
SUPPLEMENTARY SHEET**

License Number  
29-31396-01

Docket or Reference Number  
030-38199

24. The licensee is authorized to transport licensed material in accordance with the provisions of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."
25. Notwithstanding the requirements of License Condition 27 the licensee is authorized to make program changes and changes to procedures specifically identified in the condition, which were previously approved by the U.S. Nuclear Regulatory Commission and incorporated into the license without prior Commission approval as long as:
- A. The proposed revision is documented, reviewed, and approved in accordance with the letter dated February 22, 2010.
  - B. The revised program is in accordance with regulatory requirements, will not change the license conditions, and will not decrease the effectiveness of the Radiation Safety Program.
  - C. The licensee's staff is trained in the revised procedures prior to implementation.
  - D. The licensee's audit program evaluates the effectiveness of the change and its implementation.
26. The licensee will comply with the requirements for the "Order Imposing Increased Controls" (ADAMS Accession No. (ML053130183) published in the Federal Register on December 1, 2005 (70 FR 72128); and with the "Order Imposing Fingerprinting and Criminal History Records Check Requirements for Unescorted Access to Certain Radioactive Materials" (fingerprinting Order) (ADAMS Accession No. (ML073230738) published in the Federal Register on December 13, 2007 (72 FR 70901). The licensee will complete implementation of said requirements by the first day that radionuclides in quantities of concern are possessed at or above the limits specified in "Table 1: Radionuclides of Concern" contained within the fingerprinting Order. Notwithstanding any provisions of the Commission's regulations to the contrary, all measures implemented or actions taken in response to these Orders shall be maintained until the Commission orders otherwise, or until the Commission explicitly modifies its regulations to reflect the increased controls and fingerprinting requirements, and states in modifying its regulations, that the revisions are to supersede these Orders. The licensee shall notify the Director, Office of Federal and State Materials and Environmental Management Programs, U. S. NRC, Washington, DC, 20555, in writing, within 25 days after it has completed the requirements of this condition. In addition, licensee responses applicable to this license condition shall be marked as "Withhold From Public Disclosure Under 10 CFR 2.390."

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PAGE 6 OF 6 PAGES

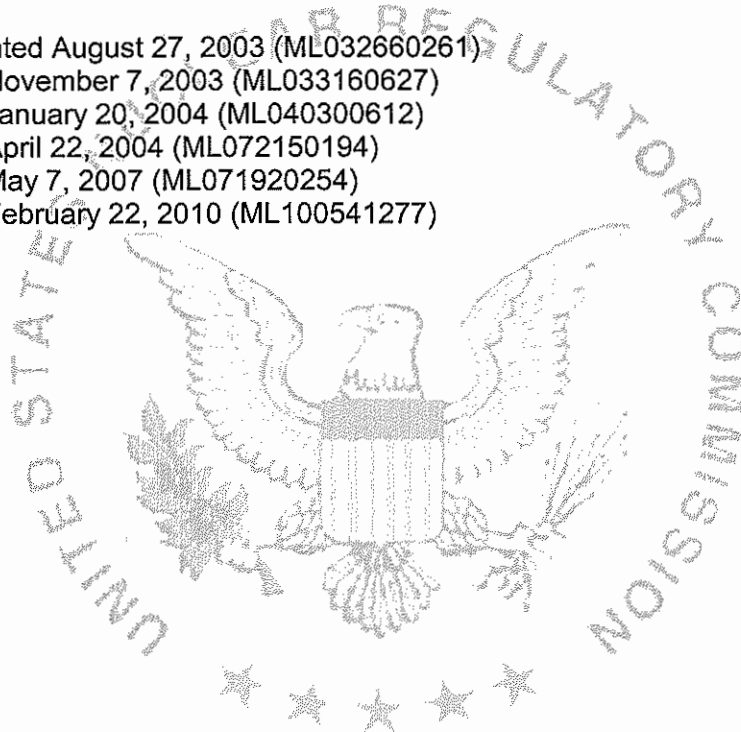
**MATERIALS LICENSE  
SUPPLEMENTARY SHEET**

License Number  
29-31396-01

Docket or Reference Number  
030-38199

27. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The U.S. Nuclear Regulatory Commission's regulations shall govern unless the statements, representations, and procedures in the licensee's application and correspondence are more restrictive than the regulations.

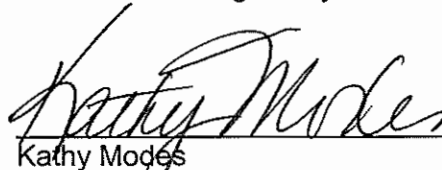
- A. Application dated August 27, 2003 (ML032660261)
- B. Letter dated November 7, 2003 (ML033160627)
- C. Letter dated January 20, 2004 (ML040300612)
- D. Letter dated April 22, 2004 (ML072150194)
- E. Letter dated May 7, 2007 (ML071920254)
- F. Letter dated February 22, 2010 (ML100541277)



For the U.S. Nuclear Regulatory Commission

Date March 2, 2010

By



Kathy Modes  
Decommissioning Branch  
Division of Nuclear Materials Safety  
Region I  
King of Prussia, Pennsylvania 19406

Tuesday, March 2, 2010 08:15:24

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION I  
475 ALLENDALE ROAD  
KING OF PRUSSIA, PENNSYLVANIA 19406-1415

March 2, 2010

Docket No. 03036414  
Control No. 144332

License No. 46-27767-01

Philip Bartley  
Vice President, ESQ  
Tetra Tech EC, Inc.  
1000 The American Road  
Morris Plains, NJ 07950

SUBJECT: TETRA TECH EC, INC., LICENSE TERMINATION, CONTROL NO. 144332

Dear Mr. Bartley:

Please find enclosed Amendment No. 7 terminating License No. 46-27767-01 as requested by your letter dated August 7, 2009. This termination is being issued in accordance with the requirements of the applicable NRC License Termination Rule (10 CFR 30.36, 10 CFR 40.42, and 10 CFR 70.38).

Current NRC regulations and guidance are included on the NRC's website at [www.nrc.gov](http://www.nrc.gov); select **Nuclear Materials; Medical, Academic, and Industrial Uses of Nuclear Material**; then **Regulations, Guidance, and Communications**. You may also obtain these documents by contacting the Government Printing Office (GPO) toll-free at 1-866-512-1800. The GPO is open from 7:00 a.m. to 6:30 p.m. EST, Monday through Friday (except Federal holidays).

Your cooperation with us is appreciated.

Sincerely,

A handwritten signature in black ink, appearing to read "Kathy Modes", is written over a printed name.

Kathy Modes  
Senior Health Physicist  
Decommissioning Branch  
Division of Nuclear Materials Safety

Enclosure:  
Amendment No. 7

cc w/enclosure:  
Erik Abkemeier, Radiation Safety Officer

## MATERIALS LICENSE

## Licensee

1. Tetra Tech EC, Inc.

2. 3200 George Washington Way, Suite G  
Richland, Washington 99354

3. License number 46-27767-01

4. Expiration date Not Applicable


5. Docket No. 030-36414  
Reference No.

In accordance with the letter dated August 7, 2009 and subsequent issuance of License No. 29-31396-01, this license is hereby terminated.

For the U.S. Nuclear Regulatory Commission

Date March 2, 2010

By

  
Kathy Modes  
Decommissioning Branch  
Division of Nuclear Materials Safety  
Region I  
King of Prussia, Pennsylvania 19406

Tuesday, March 2, 2010 07:58:12

U.S. NUCLEAR REGULATORY COMMISSION  
MATERIALS LICENSE

## Licensee

1. Tetra Tech EC, Inc.

2. 3200 George Washington Way, Suite G  
Richland, Washington 99354

3. License number 46-27767-01

4. Expiration date Not Applicable

5. Docket No. 030-36414  
Reference No.

In accordance with the letter dated August 7, 2009 and subsequent issuance of License No. 29-31396-01, this license is hereby terminated.



For the U.S. Nuclear Regulatory Commission

Date March 2, 2010

By

**Original signed by Kathy Modes**

Kathy Modes  
Decommissioning Branch  
Division of Nuclear Materials Safety  
Region I  
King of Prussia, Pennsylvania 19406

Tuesday, March 2, 2010 07:58:12

**ATTACHMENT 2**

**TETRA TECH EC, INC. RADIATION PROTECTION PLAN**

# **RADIATION PROTECTION PLAN**

## **October 2010**

**Prepared by:**



**TETRA TECH EC, INC.**

A handwritten signature in black ink, reading 'Erik J. Abkemeier'. The signature is written in a cursive style.

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Erik Abkemeier, CHP, PE, CSP, CHMM  
Corporate Health Physics Manager



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## APPENDICES

Appendix A Radiation Protection Plan Acknowledgment Form

## ABBREVIATIONS AND ACRONYMS

ALARA	as low as reasonably achievable
APP	Accident Prevention Plan
CFR	<i>Code of Federal Regulations</i>
CHPM	Corporate Health Physics Manager
DAC	derived air concentration
DOT	U.S. Department of Transportation
EHS	environmental health and safety
HRA	Historical Radiological Assessment
MOU	Memorandum of Understanding
NRC	U.S. Nuclear Regulatory Commission
PjM	Project Manager
PPE	personal protective equipment
QC	quality control
226-Ra	radium-226
RASO	Radiological Affairs Support Office
RCA	Radiologically Controlled Area
RCT	Radiological Control Technician
RMA	Radioactive Materials Area
RML	Radioactive Material License
RPG	Radiation Protection Guidance
RPP	Radiation Protection Plan
RSO	Radiation Safety Officer
RSOR	Radiation Safety Officer Representative
RTS	Radiological Task Supervisor
RWP	Radiation Work Permit
SOP	Standard Operating Procedure
SSHP	Site Safety and Health Plan
TEDE	total effective dose equivalent
TIP	Task Initiation Procedure
TtEC	Tetra Tech EC, Inc.
VPESQ	Vice President for Environmental Safety and Quality Services

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# 1. PURPOSE/INTRODUCTION

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The purpose of this Radiation Protection Plan (RPP) is to detail Tetra Tech EC, Inc.'s (TtEC's) requirements for activities conducted under Radioactive Material License (RML) No. 29-31396-01, issued and subject to regulatory enforcement by the United States Nuclear Regulatory Commission (NRC). The following activities are subject to this RPP:

- Project activities that involve the use and/or handling of licensed by-product, source, and/or special nuclear material (hereafter referred to as radioactive material)
- Tasks with the potential for radioactive material to be present based on available data and historical record
- Work in locations posted and controlled because of radioactive material

Project activities will incorporate the requirements within to maintain compliance in parallel with the current version of corporate procedure RP1-1, Radiological Protection Program.

Project activity performance steps are detailed in site-specific Work Plans, Standard Operating Procedures (SOPs), Work Instructions, Task-Specific Plans, etc. (Agencies that may have jurisdiction or an interest in project activities are also identified in such documents.) Project staff tasked to perform assignments involving the presence of radioactive material (e.g., those identified in the applicable portions of Section 2.0) will complete a review of this document and indicate an understanding of all requirements by completing a Radiation Protection Plan Acknowledgment Form (Appendix A).

## 1.1 Policy

It is TtEC's policy that work with radioactive material be purposeful and performed in a manner that protects project staff, members of the general public, and the environment. Radiologically oriented work may not begin unless it can be performed in a safe and reliable manner that is compliant with the exposure reduction rules, regulations, and principles described in Section 1.3.

## 1.2 Project-Specific Radiation Protection Plan

Corporate procedure RP1-1, Radiological Protection Program, provides the foundation for the RPP and its use for any project or activity that involves the possession or use of radioactive materials, including the subsequent potential for exposure to ionizing radiation. Content provided within this RPP reflects corporate policy and provides the guidance needed for project management to execute the scope of work in a safe manner. Site-specific guidance for radiological safety and control is further detailed in SOPs. SOPs are subject to approval by the Radiation Safety Officer (RSO) or designee and authorized for use as indicated on a Radiation Protection Program SOP Crossover Document. This document may be revised separately from the RPP. A current copy for each viable project is available upon request. The RSO is also the company's Corporate Health Physics Manager (CHPM).

### **1.3 As Low as Reasonably Achievable**

Work involving radioactive material and any corresponding exposure to ionizing radiation must be purposeful and performed in a manner sufficient to ensure the protection of staff, members of the public, and the environment. TtEC applies industry-recognized principles to radiological work so that exposure to ionizing radiation is maintained in accordance with corporate procedure NLP-01, As Low As Reasonably Achievable (ALARA) Program.

### **1.4 Authorization to Stop Work**

In accordance with corporate procedure RP1-1, Radiological Protection Program, and as detailed in Section 2.9, employees are authorized to stop work if an unsafe condition exists or safety protocol is being violated, and immediately report the condition to project management.

Work performed under a Radiation Work Permit (RWP) will stop, and the Radiological Affairs Support Office (RASO) will be notified if any of the following atypical work site conditions are encountered:

- An individual total effective dose equivalent (TEDE) exceeding 500 millirems
- The collective TEDE for the job exceeding 1 rem
- Individual airborne exposures exceeding 10 derived air concentration (DAC) hours in a 7-day period
- General area exposure rates exceeding the limits of the current radiological posting
- Contamination levels exceeding 100 times the limits, requiring classification of an area as a Contaminated Area

In cases where the RASO must be notified, the license RSO, with concurrence from the RASO, must approve the RWP before restarting work.

### **1.5 Scope of Work**

The project-specific scope of work involves the following activities:

- Task-specific training of personnel
- Site controls and establishment of work zones at sites with, or having the potential for, radioactive commodities or contaminants
- Handling and management of collected radioactive commodities, radiologically contaminated soil, or other radiologically contaminated material
- Site investigation and remediation including characterization surveys and sampling, excavation, screening for and removal of commodities, and surveys and sampling to document final conditions

## **1.6 Quality Control and Auditing**

To maintain continued compliance and evaluate overall RPP effectiveness, quality control (QC) measures including self-assessment and management reviews will be used. Formal audits, including those conducted at field projects, will be coordinated and tracked to completion by the RSO as will any need for adjustments to audit frequencies.

### **1.6.1 Self-Assessment, Management Reviews, and Audits**

A self-assessment and management review of RPP use, as detailed in corporate procedure NLP-08, Radiation Protection Program Audits, will be conducted. Project personnel including the Project Manager (PM), project Radiation Safety Officer Representative (RSOR), and on-site personnel will support and cooperate with any audit conducted.

### **1.6.2 Responses and Corrective Actions**

Radiological deficiencies must be responded to in a timely fashion. Deficiencies that represent an imminent threat to radiological control or safety (e.g., compromise of procedural protocol) will be immediately reported to the RSOR, RSO, and PM or designee(s). Subsequent corrective actions will be tracked to completion by the RSO or designee. Radiological deficiencies, including corrective actions, will be promptly reported by the RSO to the project client (e.g., the Navy; for the purposes of this RPP, Navy means U.S. Department of the Navy, Naval Facilities Engineering Command Southwest; U.S. Department of the Navy, Base Realignment and Closure, Program Management Office; and Naval Sea Systems Command Detachment, RASO). Responses to findings will be submitted to the RSO or designee for review, approval, and final disposition.

### **1.6.3 Daily Instrumentation Check**

As addressed in Section 3.16, survey instruments procured for field use will have proof of current calibrations in accordance with the manufacturers' procedures, employing applicable standards and sources traceable to the National Institute of Standards and Technology. Copies of instrument calibration certificates will be maintained on-site for reference. Instruments will be response-checked daily in accordance with applicable SOPs. (In addition to the manufacturers' instruction manuals, typical project instruments and their performance characteristics are identified in site-specific controlling documents such as a Site-Specific Radiological Work Plan.)

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## 2. RADIATION PROTECTION PERSONNEL

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This section details the radiological safety responsibilities vested with key personnel within the project. (Nonradiological safety responsibilities will be detailed in a separate project-specific Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP). Reporting relationships between TtEC support personnel and the client (e.g., the Navy) will be referenced in a site-specific controlling document as well (e.g., a Site-Specific Radiological Work Plan).

### 2.1 Vice President for Environmental Safety and Quality Services

The Vice President for Environmental Safety and Quality Services (VPESQ) has overall responsibility for TtEC's safety operations. The VPESQ is responsible for:

- Ensuring proper maintenance of the RPP consistent with applicable regulatory mandates, TtEC corporate policy, and recognized industry practice
- Establishing and maintaining all necessary management oversight specific to the RPP
- Implementing a management review process to ensure applicable use of RPP requirements

### 2.2 License Radiation Safety Officer (Corporate Health Physics Manager)

The CHPM (also referred to as the RSO) is appointed by the VPESQ as the senior health physicist and the Health Physics Resource Manager for TtEC. The CHPM is responsible for:

- Reviewing and making recommended revisions to:
  - The RPP, RML procedures, radiation protection guidelines, and supporting documents
  - Project plans involving the use or handling of radioactive materials, or access to areas of radiological concern to ensure compliance with RPP requirements and supporting guidelines
- Acting as the Health Physics Resource Manager, also referred to as the corporate-level or license RSO
- Designating a Project Health Physicist, also referred to as the project-level RSOR, to provide day-to-day guidance on radiological protection issues
- Compliance as the license RSO, with RML No. 29-31396-01, including:
  - Primary point of contact for all communications to the NRC
  - Identification and training of RML authorized users
  - Assignment of project RSORs

- Coordination of investigations involving radiological occurrences to include review and approval of a resulting Corrective Action Plan
  - Advance NRC notification in writing at least 14 days before initiating at a temporary job site under TtEC RML jurisdiction any activity, or change to scope involving new activities, in areas of radiological concern (excluding routine packaging or repackaging for purposes of transporting and not requiring a job- or site-specific work package, and characterization and/or final surveys where radioactive materials and/or radiation are not likely to be detected)
  - Refrain from taking ownership of licensed materials in excess of possession limits without prior notification and written NRC approval
  - Advance NRC notification in writing within 30 days of the temporary job site completion status involving decontamination and decommissioning activities, and disposition of any licensed material as related to RML jurisdiction
  - Placement of reciprocity request with applicable Agreement States when necessary
  - Maintenance of radiological exposure records
  - Development and/or approval of radiation safety training materials and/or courses
  - Performance of program audits as detailed in corporate procedure NLP-08, Radiation Protection Program Audits
  - Providing guidance on radiological protection issues
  - Identification of appropriate project staffing needs to implement RPP requirements
  - Assistance with the development of site Environmental Health and Safety (EHS) plans and approval of EHS plans for projects that involve the use or handling of radioactive materials or access to areas of radiological concern
  - Resource Specialist review for Task Initiation Procedures (TIPs) for proposed projects involving exposure to radiation or radioactive materials
- Delegating project responsibilities to other company health physicists (also referred to as RSORs), as necessary

### **2.3 Project Radiation Safety Officer Representative (Project Health Physicist)**

The project RSOR, also referred to as the Project Health Physicist, is assigned by the RSO and vested with corporate-level authority to implement the RPP and the TtEC RML at a project site. Whenever radiological work is actively ongoing under the TtEC RML, the RSOR or designee identified as an authorized user will be present at the project site. The RSOR is vested with the following responsibilities at projects subject to jurisdiction involving the TtEC RML:

- Providing health physics guidance on an as-needed basis

- Conducting required radiological safety training
- Reviewing and approving project field procedures that involve the handling of radioactive materials or access to areas of radiological concern
- Conducting radiation incident investigations and project inspections
- Maintaining a project site file that details radiological protection training provided, dosimetry records generated, radiological surveys performed, and other documentation pertinent to the RPP, RML procedures, radiation protection guidelines, and supporting documents; copies of these will be provided to the CHPM at the conclusion of the project
- Arranging for and assisting in program radiation protection audits as detailed in the most current version of corporate procedure NLP-08, Radiation Protection Program Audits
- Assisting in the development and approval of the site EHS plan
- Helping in the identification of project radiological analysis needs and selection of analytical support contractors
- Coordinating required ALARA reviews
- Ensuring appropriate staff work practices are employed to maintain occupational radiation exposures ALARA
- Ensuring items needed to perform work in accordance with the RPP, RML, and supporting documents are available, such as appropriate instrumentation, protective devices, dosimetry, etc.
- Directing the preparation of, and performing the review and approval of, RWPs
- Stopping work if necessary to ensure radiological safety
- Communicating with the PM and RSO as needed to ensure the RPP is implemented correctly
- Ensuring proper operation of radiation-measuring equipment, including the performance of daily function and QC tests, and removing out-of-compliance instruments from service
- Maintaining radiation-measuring equipment in accordance with manufacturers' recommendations
- Directing and supervising the performance of radiological surveys and sampling in accordance with the most current version of this RPP and supporting TtEC SOPs
- Reviewing survey reports and instrument performance data for accuracy, completeness, and compliance with project, procedural, and regulatory requirements

- Ensuring work is performed in accordance with current versions of project plans, procedures, and the RPP

The project RSOR reports to and receives technical direction from the RSO, advises the PM on radiation protection and radiological operation matters, coordinates with the PM on day-to-day project activities, and communicates and coordinates radiation protection and radiological operation activities with the RSO and the client. Company Health Physicists (also referred to as RSORs) may delegate project responsibilities to other staff members deemed qualified for the task assigned.

## **2.4 Project Manager**

The PM is responsible for:

- Ensuring implementation of and compliance with the RPP requirements and current versions of the following support documents applicable to the project:
  - TtEC RML procedures (i.e., applicable NRC License Procedures)
  - TtEC Radiation Protection Guidance (RPG) documents
- Forwarding any TIP or modified TIP involving exposure to ionizing radiation or radioactive material to the RSO or designee for input and review (involvement includes the use of subcontractors who may use radioactive materials or radiation-generating devices in the course of corresponding work such as field radiography, soil density gauges, well logging, etc.)
- Determining with the assistance of the RSO or designee whether the project is required to use the TtEC RML or whether activities will fall under a Department of Energy, NRC, Agreement State, or other license
- Working with the license RSO in accordance with corporate procedure RP1-1, Radiological Protection Program, to identify applicable NRC and Agreement State requirements for projects that will not use the TtEC RML
- The safe conduct of work in compliance with all permits, client contracts, and other controlling documents that apply
- Exposure to radiation ALARA by project staff
- Adequate resources and staffing to develop and implement this RPP in compliance with applicable regulations and requirements
- The PM reports to the TtEC Program Manager.

## **2.5 Construction Manager/Project Superintendent**

Responsibilities for the Construction Manager/Project Superintendent include:

- Ensuring assigned personnel comply with radiological requirements

- Supplying relevant information to the RSOR on planned work activities and proposed applications necessary to maintain occupational radiation exposures ALARA
- Timely RSOR and PM notification of radiological problems or issues encountered
- Verifying staff is sufficiently prepared for assigned tasks (e.g., appropriate tools and equipment needed to minimize the time spent in areas of radiological concern)
- Confirming that escorted visitors accessing areas of radiological concern are properly supervised and exhibiting safe work practices in accordance with RPP protocol

The Project Superintendent/Construction Manager reports to the PM.

## **2.6 Radiological Task Supervisor**

The Radiological Task Supervisor (RTS) is the TtEC representative responsible for Radiological Control Technician (RCT) oversight and corresponding field operations conducted in areas of radiological concern. Designated as an authorized user at projects subject to jurisdiction under the TtEC RML, the RTS is vested with the following responsibilities:

- Supporting required ALARA reviews
- Coordinating plans for field activities with the Construction Manager/Project Superintendent to ensure exposure to radiation is maintained ALARA and in accordance with corresponding RWPs
- Supervising the preparation of, and performing review of, RWPs
- Stopping work if necessary to ensure radiation safety
- Maintaining communication with the RSO, RSOR, PM, Construction Manager, and Project Superintendent as needed to ensure the RPP is fully implemented
- Confirming proper operation of radiation survey instruments, including the validation of daily function and QC checks, and removing noncompliant instruments from service
- Ensuring radiation survey instruments are maintained in a way that complies with manufacturer instructions and recommendations
- Directing and supervising the performance of radiological survey and sampling practices in accordance with the RPP, current versions of applicable SOPs, and corresponding RWPs
- Validating field survey reports and instrument performance data for accuracy, completeness, and compliance with the RPP, applicable SOPs, and corresponding RWPs
- Participating in periodic internal and external reviews of RPP content and implementation
- Supporting self-assessments and management reviews as needed and correcting identified deficiencies within the allotted time frame

The RTS reports to and receives technical direction from the RSOR.

## **2.7 RADIOLOGICAL Control Technicians**

The RCTs are responsible for:

- Ensuring occupational exposure to radiation is maintained ALARA
- Preparing, using, and adhering to the RWP
- Stopping work if necessary to ensure radiological safety
- Performing radiation surveys and other radiological safety tasks in accordance with the RPP, applicable SOPs, and corresponding RWPs
- Confirming proper operation of assigned radiation survey instruments prior to field use to include verification of daily function and QC performance checks, and removing noncompliant instruments from service
- Using radiation survey instruments in accordance with the RPP, applicable SOPs, and corresponding RWPs and maintaining the instruments in a way that complies with manufacturers' instructions and recommendations

The RCTs report to and receive technical direction from the RTS.

## **2.8 Radiation Workers (Field Personnel)**

Project staff (including the general labor force associated with TtEC and its subcontractors) who have the potential to receive occupational exposure to radiation while on the job site, and who are expected to work under the requirements of this RPP as radiation workers, will:

- Receive sufficient training, prior to beginning work, in accordance with the most current version of corporate document RPG 2-5, Radiation Safety Training.
- Report to the RTS or RCT any nonoccupational radiation exposures that result from the use of medical or dental applications more aggressive than a standard X-ray.
- Comply with requirements of all procedures and guidelines applicable to the project.
- As required, exercise stop work authority and report radiological safety issues or concerns, including incidents and unplanned events, immediately to project management and Environmental Safety and Quality staff in writing, verbally, or with a Zero Incident Performance<sup>®</sup> slip; respond promptly to any stop-work and/or evacuate orders.
- Display use of industry recognized radiological work practices when inside areas of radiological concern, and conform promptly to instructions when provided by RCTs.
- Strictly adhere to radiological control procedures, guidelines, and postings including information provided in RWPs.

- Immediately report lost dosimetry devices to the RCT.
- Report planned medical radiation treatments in advance to supervision and the project RSOR and prior to entering areas of radiological concern or wearing dosimetry.
- Periodically confirm personal radiation exposure status and ensure that administrative dose guidelines are not exceeded.
- Notify the RCT of faulty or alarming radiological protection equipment.

When in areas of radiological concern, workers report to the RTS.

## **2.9 Stop Work Authority**

Company and subcontractor personnel will have the responsibility and authority to stop work when controls are inadequate or imminent danger exists. In any situation in which stop work authority is used, the following requirements will apply:

- Exercise stop work authority in a justifiable and responsible manner.
- Once work is stopped, do NOT resume until proper controls have been established.
- Resumption of work will require concurrence by the PM or designee.

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### 3. TASK-SPECIFIC HAZARD ANALYSIS/CONTROLS

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A task-specific hazard analysis is performed on a daily basis to allow for risk identification associated with site work, including physical, chemical, and radiological components. (Radiation exposures that result from naturally occurring background sources and medical applications conducted under the care of a physician are examples of dose that is independent of occupational monitoring requirements but considered when planning task assignments. In instances of verifiable therapeutic applications, employee-furnished notifications will be used as an informational reference and included as part of a corresponding radiation exposure file.)

Risk-based hazards and controls are defined in a site-specific Activity Hazard Analysis. Anticipated physical and chemical risks are described in detail in the project-specific APP/SSHP. Radiological risk controls are categorized in the sections to follow, and protective measures apply as defined in task-specific RWPs and corresponding SOPs.

#### 3.1 Identification of Radiation Risks

Project tasks subject to RPP protocol indicate a known or suspected likelihood of activities occurring in radiologically impacted areas (e.g., locations with sources of radium-226 [226-Ra], areas with similar radionuclides of concern as identified in a site-specific Historical Radiological Assessment [HRA]).

#### 3.2 Controlling Documents

Unless indicated otherwise in Section 1.0, work conducted under the RPP will be subject to requirements detailed in TtEC RML No. 29-31396-01 and in accordance with any project-specific Memorandum of Understanding (MOU) criteria and applicable radiological control work documents (e.g., site-specific Base-wide Radiological Plan, SOPs). TtEC will incorporate site-specific versions of SOPs as needed to implement and satisfy license commitments. Title 10 of the *Code of Federal Regulations* (CFR) Section 20 applies to the RPP standards used. In parallel, industrial safety requirements and U.S. Environmental Protection Agency regulations detailed in 29 and 40 CFR also have applicability for a variety of regulatory subjects including Comprehensive Environmental Response, Compensation, and Liability Act; the Resource Conservation and Recovery Act; and the National Emission Standards for Hazardous Air Pollutants.

#### 3.3 Evaluation of Potential Exposure to Workers

RPP dose limits for the control of occupational exposure to ionizing radiation are listed in 10 CFR 20.1201–1208. Dose limits for individual members of the public are detailed in 10 CFR 20.1301–1302. In accordance with TtEC policy, all exposures will be minimized to the extent practical. Administrative guidelines, established below the federal limits, will be used as detailed in the current version of corporate procedure NLP-01, As Low As Reasonably Achievable Program. Occupational exposures for project personnel will be maintained below TtEC administrative values for annual TEDE.

Occupational dose, if any, is expected to originate from external sources (e.g., 226-Ra, cesium-137, or strontium-90 or similar known radionuclides of concern as listed in a site-specific reference document [e.g., HRA]). Dose resulting from internal exposures is not anticipated. External

exposure controls are addressed in Section 3.8, and controls to prevent or limit internal exposures are detailed in Section 3.9. Dose rates for general area work sites are expected to reflect naturally occurring background values.

### **3.4 Evaluation of Public Dose**

Based on the scope of planned work, the limited activity of radionuclides expected, and low concentration of naturally occurring radioactive material anticipated, public dose associated with tasks performed under this RPP is not projected. To validate the maintenance of public dose goals, TtEC will implement necessary survey and sampling protocol in areas of intrusive work, conspicuously post and restrict access to intrusive work locations that require monitoring (e.g., areas where soil excavations and/or handling, etc., may disturb sources of radioactive material), and validate survey and sampling results and frequencies with the client (e.g., RASO), RSO, RSOR, and RTS representatives to ensure established controls are effective.

### **3.5 Training Program**

Site personnel tasked to conduct project-oriented activities must satisfy corresponding APP/SSHP training requirements. Persons subject to assignments involving a known or suspected potential for occupational radiation dose will receive additional training commensurate with radiological awareness requirements as defined in 10 CFR 19.12, Instructions to Workers. Visitors and escorted persons must receive a site briefing and will be assigned to a qualified radiation worker aide when in an area of radiological concern.

#### **3.5.1 Site Briefing**

An RPP site briefing is designed for an escorted person and is presented when access is needed to radiologically impacted locations. Specific to the area(s) of concern where access is needed, the RPP brief will cover at a minimum:

- Applicable portions of 10 CFR 19, 10 CFR 20, the RPP, RWPs, site-specific reference documents (e.g., HRA), and supporting SOPs
- A description of radiation exposure risks and monitoring requirements
- Access and egress protocol specific to the radiologically impacted location(s) requiring entry
- Radiation exposure reduction techniques for an embryo/fetus
- Completion of applicable briefing/exposure monitoring documentation
- Notification of contacts as needed to complete training requirements

#### **3.5.2 Radiation Worker Training**

RPP training for the radiation worker is provided when unescorted access is needed to impacted site locations subject to radiological control. Inclusive of material that may be required by project-specific Work Plans and documents (e.g., APP/SSHP, Task-Specific Plans), training may be presented in the form of a group overview, video presentation, etc., with use of printed handouts approved by the RSOR. Training will address at a minimum:

- Applicable portions of 10 CFR 19, 10 CFR 20, the RPP, site-specific reference documents, and supporting SOPs specific to task performance
- A description of radiation exposure risks, monitoring requirements, and techniques
- Access and egress protocol specific to radiologically impacted locations
- Required contacts and expected actions in the event of an emergency (in accordance with the current version of corporate procedure NLP-06, Managing Radiological Emergencies)
- Expected actions and contacts if radioactive material is discovered in an area where it is not expected
- Understanding “hands and feet” and “whole body” monitoring requirements
- Risks with radioactive material and radiation-producing devices unique to the site
- ALARA work principles and techniques
- Understanding the requirements for and compliance with RWPs including protocol for dosimetry and personal protective equipment (PPE)
- Radiation exposure reduction techniques for the embryo/fetus
- Completion of applicable training and exposure monitoring documentation
- Notification of contacts as needed to complete training requirements

### **3.5.3 Radiological Control Technician Training Qualification**

As coordinated between the RSO and RSOR, TtEC will evaluate and ensure acceptable qualification of RCTs. When selected for project assignment, RCT qualifications are evaluated between the RSO and RSOR in accordance with the requirements detailed in NRC License No. 29-31396-01. Project-specific training is provided to RCTs commensurate with anticipated duties and assignments.

### **3.6 Declared Pregnant Female Worker**

To maintain embryo/fetus radiation exposure ALARA, female employees who are pregnant or attempting to become pregnant are encouraged to declare this information to project management in writing to allow for criteria to be exercised as detailed in:

- 10 CFR 20.1208, Dose Equivalent to an Embryo/Fetus
- NRC Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure, Revision 3, Washington, DC (NRC 1999)
- NRC Regulatory Guide 8.29, Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1, Washington, DC (NRC 1996)

Because of the small anticipated annual dose for workers associated with project activities (i.e., less than 10 millirems/year), it is unlikely in instances of pregnancy that separate dose tracking for the embryo/fetus will be necessary. Managing occupational exposures for all staff within annual TtEC administrative TEDE guidelines is expected to satisfy parallel maintenance of less than 500 millirems total dose for any pregnant female worker over the course of an entire gestation period.

### **3.7 As Low as Reasonably Achievable Program**

TtEC is committed to maintaining radiation exposure to workers and the public as far below company guidelines and regulatory limits as practical. RPP requirements are established for field operations in an effort to meet that commitment in accordance with the current version of corporate procedure NLP-01, As Low As Reasonably Achievable Program.

### **3.8 External Exposure Control**

The following steps will be taken to control external radiation exposure to levels that are ALARA:

- Employ basic dose reduction strategies as detailed in corporate procedures and site-specific SOPs using the ALARA concepts of time, distance, and shielding.
- Use instruments at frequencies sufficient to accurately determine the level and extent of radiation fields.
- Present adequate staff training to ensure the ability to recognize situations involving objects that might be radioactive, to be wary of objects that are unfamiliar, and to rely on valid instrument readings to limit and safely manage external exposure.

### **3.9 Internal Exposure Control**

Internal exposure is expected to be below all the recognized DAC values as specified in 10 CFR 20. Should the potential for internal dose be confirmed during fieldwork (e.g., due to the nature of the planned activity such as remediation efforts), the activity will be temporarily suspended and the work area secured pending determination and use of corrective protocol as decided among the RSO, RSOR, and PM.

### **3.10 Monitoring and Measuring External Exposure**

A vendor accredited by the National Voluntary Laboratory Accreditation Program will be used to provide project-related dosimetry services. Dosimetry applications and considerations will apply to field staff designated as radiation workers (i.e., personnel needing unescorted access to impacted site locations subject to radiological control). Prior to dosimetry issue, a radiation worker will have satisfactorily completed requirements as detailed in Section 3.5.2.

### **3.11 Monitoring and Measuring Internal Exposure**

The monitoring of work practices conducted in areas of radiological concern will be coordinated among the RCTs, RTs, and members of project management designated as radiation workers using frequencies necessary to confirm the application of correct techniques and PPE to minimize potential transfer of external contaminants inside the body.

Air sampling will be performed during intrusive activities conducted in areas of radiological concern. Air sample results will be reviewed and tracked among the RSO, RSOR, RTS, and designated RCTs to determine whether trends (e.g., concentrations greater than 10 percent of DAC) exist that require work stoppage and/or re-engineering of task-specific contamination controls.

### **3.12 Surveys and Monitoring**

A project-based summary of historic survey and monitoring information is typically available in site-specific documentation (e.g., an HRA manual or Base-wide Radiological Work Plan). Protection of workers, the public, and the environment depends on accurate assessment and interpretation of past historic information as compared to present-day survey data collected in accordance with prescribed procedures and project support documents.

In situations subject to this RPP, guidance for determining survey frequency and technique is detailed in applicable portions of corporate procedures NLP-04, Radiological Entry Control Program, NLP-05, Radioactive Contamination Control, and RPG 2-9, Radiological Surveys and Operational Checks. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

#### **3.12.1 Surveys of Equipment and Materials**

Equipment and material passing through areas controlled for radiological concern will be subject to survey criteria and techniques detailed in applicable portions of corporate procedure NLP-05, Radioactive Contamination Control. In parallel, supplemental site-specific documentation may be authorized for use by the RSO if indicated on a Radiation Protection Program SOP Crossover Document.

### **3.13 Action Levels**

Action levels represent transition points at which concentrations of radioactivity require additional response and/or investigation (e.g., PPE upgrades or increased work technique controls). Action levels for radiological controls are detailed in corporate procedure NLP-01, As Low As Reasonably Achievable Program, and NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document. Modification to project-specific action levels requires client (e.g., Navy) concurrence.

### **3.14 Radiologically Controlled Areas and Posting**

Site structures, outdoor locations, and/or perimeter boundaries posted with yellow and magenta markings are established to identify areas designated for radiological control, prevent (to the extent practical) access by unauthorized persons, and protect members of the public from exposure to radiation. A detailed description of scenarios and postings used for control purposes is provided in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

### **3.14.1 Controlled Area**

A Controlled Area may be established where access to impacted portions of a work site requires specialized qualification and approval. A Controlled Area (which may also be called a Restricted Area) is intended to serve as the outermost boundary around planned and established work zones.

Controlled Area access requires prior authorization and use of PPE as defined in a project specific APP/SSHP. Visitors must have requisite training as specified in an SSHP. Personnel who enter a Controlled Area may not cross into more restrictive areas posted within unless prior authorization is obtained.

Where the perimeter to a Controlled Area is first encountered for radiological purposes, posting applications will have the wording “Caution Controlled Area” (or Restricted Area) and provide a contact phone number. (Supplemental information as specified by the RSOR or designee may also be included as magenta [preferred], purple, or black markings on a yellow [preferred] or white background). A minimum of one sign will be posted on each straight run of the Controlled Area (or Restricted Area) boundary. Note that areas not typically accessed by pedestrians (e.g., windows) need not be posted. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

### **3.14.2 Access Control Point**

When used, an Access Control Point is part of a Controlled Area (or Restricted Area) boundary. Intended to serve as a transition corridor, an Access Control Point allows for the accountability of personnel, tools, and equipment that pass through. When established as a radiological control mechanism, an Access Control Point RCT will be present any time activities within are ongoing. During periods of inactivity, control point gates (part of the contiguous area boundary) are closed and locked.

### **3.14.3 Radiologically Controlled Area**

A Radiologically Controlled Area (RCA) represents an area in which a person who works for 1 year might receive a whole body dose in excess of 100 millirems from all pathways (excluding natural background and medical exposures). For external sources, the RCA is typically posted when the dose rate of 30 centimeters exceeds 50 microrems per hour, although this may be modified at the discretion of the license RSO based on accurately assessed occupancy factors. Intended to include (for posting purposes) the nearest boundary or perimeter associated with the affected area, RCA restrictions and corresponding access protocol can be located in supplemental site-specific documentation.

When used, a minimum of one sign will be posted on each straight run of the RCA boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary. For waterfront areas, signs should be posted at areas accessible by watercraft.

### **3.14.4 Radioactive Materials Area**

A Radioactive Materials Area (RMA) identifies any area or room in which there is used or stored an amount of licensed material exceeding 10 times the quantity of such material specified in Appendix C, Title 10, Part 20 of the CFR. Intended to warn of the potential for occupational dose, a description of RMA scenarios and postings used for control purposes can be located in applicable

portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

When used, a minimum of one sign will be posted on each straight run of the RMA boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

### **3.14.5 Contaminated Area**

A Contaminated Area is any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors (AEC 1974), but do not exceed 100 times those values. Contamination is radioactive material that is deposited on a surface where it is unwanted. Subject to license control, a description of Contaminated Area scenarios and postings used for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

When used, a minimum of one sign will be posted on each straight run of the RCA boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

### **3.14.6 High Contamination Area**

A High Contamination Area is any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Regulatory Guide 1.86 (AEC 1974). High Contamination Area scenarios and postings used for control purposes are detailed in applicable portions of supplemental site-specific documentation (e.g., Department of Energy Procedures for Radiologically Restricted Areas – Posting and Access Control per 10 CFR 835) and may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

When used, a minimum of one sign will be posted on each straight run of the High Contamination Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

### **3.14.7 Radiation Area**

A Radiation Area means any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates. A description of Radiation Area scenarios and postings used for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

When used, a minimum of one sign will be posted on each straight run of the Radiation Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

### **3.14.8 High Radiation Area**

A High Radiation Area means any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. A description of High Radiation Area scenarios and postings used for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

When used, a minimum of one sign will be posted on each straight run of the High Radiation Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

### **3.14.9 Airborne Radioactivity Area**

An Airborne Radioactivity Area is a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations:

- In excess of the DACs specified in Appendix B to 10 CFR 20.1001–20.2401, or
- To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake or 12 DAC hours.

As an example, for 226-Ra, the most likely airborne contaminant at Navy radiological remediation projects, the applicable DAC value is 3.0E-10 microcuries/milliliter. A description of Airborne Radioactivity Area scenarios and postings used for control purposes can be found in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized for use by the RSO if indicated on a Radiation Protection Program SOP Crossover Document.

When used, a minimum of one sign will be posted on each straight run of the Airborne Radioactivity Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

## **3.15 Contamination Control**

Contamination control practices are established to preclude the spread of contaminants into uncontrolled areas. Recognized applications are detailed in corporate procedure NLP-05, Radioactive Contamination Control.

In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

### **3.15.1 Physical Boundary**

A physical boundary will be established using criteria referenced in Section 3.14.4 to fully enclose a location established as a Contaminated Area.

### **3.15.2 Entry**

Entry into a Contaminated Area will be compliant with pre-established requirements as detailed on a job-specific RWP. In such instances, an RCT will be present to assist in radiological control and support. (See Section 3.17.1 for details on RWP use.)

### **3.15.3 Exit**

Exit from a Contaminated Area will be compliant with pre-established requirements as detailed on a job-specific RWP. In such instances, an RCT will be present to assist in radiological control and support. (See Section 3.17.1 for details on RWP use.)

### **3.15.4 Limitations on Entry**

Personnel with open wounds or sores are not generally granted access into a Contaminated Area. Entry may be authorized by the RSOR or designee, on a case-by-case basis, if appropriate protection of the wound or sore is verified, planned work activities are unlikely to compromise the protection, and there is no other medical reason to restrict entry.

Jewelry and personal items are not allowed in Contaminated Areas; only project furnished tools, materials, and equipment necessary to accomplish the planned task are acceptable. Container wrappings, packing, and similar materials must be segregated from essential items prior to entry.

### **3.15.5 Control of Items**

Items such as equipment and tools to be removed from a Contaminated Area must meet unconditional release criteria as detailed in applicable portions of corporate procedure NLP-05, Radioactive Contamination Control. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

## **3.16 Instrumentation**

As detailed in applicable portions of corporate procedure RPG 2-9, Radiological Surveys and Operational Checks, field survey instruments will be calibrated annually at a minimum in accordance with the manufacturers' specifications. Instruments will be removed from service on or before calibration due dates and returned to the supplier for recalibration. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

## **3.17 Control of Radiological Work**

All radiological work activities will be planned in consultation with the RSOR, the PM, and other project personnel tasked with oversight responsibilities. Work performed in areas of radiological concern require establishment of an RWP, which details radiologically based requirements and protective measures.

### **3.17.1 Radiation Work Permits**

RWPs detail the protective measures and controls needed to perform tasks in areas of radiological concern. Information considered during RWP development is detailed in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-

specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

### **3.17.2 Task-specific Work Instructions**

Task-specific work instructions are used to supplement RWP requirements and address in greater detail corresponding activities planned while personnel are inside areas of radiological concern. These instructions are required for tasks scheduled to occur in locations as determined by the PM, RSO, RSOR, or the Construction Manager. The RSO or designee will finalize, control, and issue radiologically based work instructions.

### **3.18 Credentialing of Staff**

Qualification and training requirements for RCTs are provided in NRC License No. 29-31396-01 and are detailed in applicable portions of corporate procedure RPG 2-5, Radiation Safety Training. The RSO verifies qualifications and conducts required license-specific training with any RSOR designated on the license as an authorized user.

To supplement and validate the correct use and implementation of this RPP and NRC License No. 29-31396-01, a Health Physicist certified by the American Board of Health Physicists provides support to active field projects.

### **3.19 Procurement, Receipt, and Inventory OF SEALED RADIOACTIVE SOURCES**

It is not anticipated that field projects will receive radioactive material shipments other than exempt-quantity radioactive check sources. As detailed in corporate procedures NLP-02, Radioactive Material Accountability, and NLP-03, Sealed Radioactive Source Control, check sources are controlled, stored, posted, and managed as radioactive material.

#### **3.19.1 Leak Testing**

Radioactive sealed sources with quantities exceeding the licensable threshold will be leak-tested as detailed in applicable portions of corporate procedures NLP-02, Radioactive Material Accountability, and NLP-03, Sealed Radioactive Source Control. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

#### **3.19.2 Transport of Sources**

Check sources will be used on field projects only for the period of time necessary to execute planned work, will not be introduced onto a project location prior to project initiation, and will be returned to the provider immediately following the completion of planned field activities.

Check sources will be maintained as detailed in applicable portions of corporate procedures NLP-02, Radioactive Material Accountability, and NLP-03, Sealed Radioactive Source Control. In parallel, supplemental site-specific documentation may be authorized for use by the RSO if indicated on a Radiation Protection Program SOP Crossover Document.

#### **3.19.3 Reporting Lost, Damaged, or Stolen Sources**

As detailed in applicable portions of corporate procedures NLP-02, Radioactive Material Accountability, and NLP-03, Sealed Radioactive Source Control, if a check source is lost, damaged,

or stolen, the event will be reported immediately to the RSOR or designee. The RSOR will immediately notify the RSO, the PM, and the client (e.g., the Navy) and initiate appropriate recovery actions. In consultation with the client, a report will be filed by the RSO or designee with the appropriate law enforcement agency if it is determined that radioactive material was stolen. The RSO will make any necessary notifications to the NRC.

Supplemental site-specific documentation may be authorized for use by the RSO if indicated on a Radiation Protection Program SOP Crossover Document.

### **3.20 Shipping and Transportation of Radioactive Materials**

Off-site shipment of radioactive materials other than exempt-quantity radioactive check sources by TtEC is not anticipated. Information pertinent to an authorized shipper for a field project is provided in Section 6.0.

### **3.21 Control of Radioactive Waste**

Radioactive waste will be minimized by compliance with contamination control practices (Section 3.15) combined with segregation and survey practices. A waste shipment provider contracted to the client (e.g., the Navy through the Army Joint Munitions Command) will provide brokerage services including waste characterization sampling, waste containers, and transportation of radioactive materials/waste generated from a field project. Soil and used PPE will typically be processed for final disposition in disposal bins. When filled, bins will be transferred to the custody and control of the authorized shipper. As detailed in corporate procedure NLP-02, Radioactive Material Accountability, commodities are stored in a locked radioactive materials storage area, are controlled by the RSOR or designee, and will periodically be packaged and transferred to the authorized shipper for disposal. Radioactive material will be packaged, stored, shipped, and disposed of as required by U.S. Department of Transportation (DOT) regulations.

In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

### **3.22 Radiation Protection Records**

As detailed in the applicable portions of corporate procedure NLP-07, Radiological Protection Records, the RSO or designee is responsible for ensuring that airborne monitoring, contamination surveys, and exposure/dose rate surveys are reviewed for accuracy and completeness as an on-going process. Individual exposure records including dosimetry and bioassay reports for personnel are reviewed for results as generated.

### **3.23 Reports and Notifications**

Workers who have previous occupational work history with radiological environments will supply the RSO or designee with prior estimated or reported dose histories on an NRC Form 4 or equivalent as defined in 10 CFR 20.2104.

Records of radiation exposures to workers who have been issued external dosimetry monitoring devices will be maintained. Dosimetry monitoring results for workers will be reported to the RSO annually at a minimum. Annual occupational exposure greater than or equal to 100 millirems for the

previous calendar year, or otherwise when requested, requires a summary of individual exposure to be reported to the employee monitored.

### **3.24 Licenses**

Entities subject to the use of this RPP will conduct radiological-based tasks with use of TtEC NRC License No. 29-31396-01. TtEC will ensure that the Radiological Control Program and work practices are implemented and performed in accordance with the NRC license requirements and the RPP. (Any client-designated waste shipment provider may implement their NRC-issued license to conduct waste characterization sampling of waste material in support of low-level radioactive waste shipment and disposal. An MOU between TtEC and a waste shipment provider will be developed, identifying interfaces and commitments for the transfer of radioactive materials. Active MOUs will be maintained by the RSO or designee.)

### **3.25 Review and Approvals of Radiation Protection Plans**

The RSO or designee will prepare the RPP, which will then be reviewed for approval with subject matter experts (e.g., the PM, RSOR). In addition, the client (e.g., the Navy) will have an opportunity to review the draft content, provide input, and indicate acceptance of the plan. Changes to the RPP will be reviewed and accepted following the same process.

### **3.26 Planned Special Exposures**

No anticipated event within work scopes subject to this RPP will require use of a planned special exposure. In the event it is necessary to initiate such a need, an activity-specific work instruction including a formal ALARA review and an RWP will be prepared and submitted for acceptance following the same process as the RPP submittal in Section 3.25.

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## **4. PERSONAL PROTECTIVE EQUIPMENT**

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Minimum PPE requirements based on chemical contaminants are established by the Health and Safety Manager (in a project-/task-specific APP/SSHP). This primary level of PPE, Level D, is historically sufficient for radiological work activities and is supplemented by activity-specific RWPs based on the radiological conditions and field tasks required to perform planned activities. Information considered for PPE during RWP development is detailed in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

### **4.1 Selection of Personal Protective Equipment**

Personnel must wear PPE commensurate with contamination hazards associated with both the work area and the planned activity. Activities that require heavy physical effort or that have an increased potential for damage to PPE may require additional layers or different PPE materials, even in areas of low contamination. Site- or task-specific PPE requirements beyond the minimum traditionally used will be detailed in a corresponding RWP.

In parallel, supplemental site-specific documentation may be authorized for use by the RSO if indicated on a Radiation Protection Program SOP Crossover Document.

### **4.2 Donning and Doffing Personal Protective Equipment**

To prevent contamination of personnel or the spread of contamination, PPE must be donned and doffed in a specific manner. Directions for donning and doffing standard PPE ensembles are provided in the applicable sections of corporate procedure NLP-05, Radioactive Contamination Control. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document. Additional instructions for non-standard site- or task-specific PPE requirements will be provided in the applicable RWP.

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## **5. DECONTAMINATION PROCEDURES**

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Decontamination will be performed at a dedicated location (e.g., decontamination pad, room) according to steps detailed in applicable portions of corporate procedure NLP-05, Radioactive Contamination Control. In parallel, supplemental site-specific documentation may be authorized by the RSO for use if indicated on a Radiation Protection Program SOP Crossover Document.

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## **6. SHIPPING AND TRANSPORTATION OF RADIOACTIVE MATERIALS**

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Field projects subject to the use of this RPP will conduct radiological-based activities with use of TtEC NRC License No. 29-31396-01. The client-designated waste shipment provider associated with a field project (e.g., Environmental Management Services, Inc. for the Navy) may implement their NRC-issued license to conduct waste characterization sampling of waste material in support of low-level radioactive waste shipment and disposal. An MOU between TtEC and a waste shipment provider will be used, identifying interfaces and commitments for the transfer of radioactive materials. In such instances, a current MOU will be maintained by the project RSOR for projects subject to the requirements of the RPP.

Environmental samples shipped for off-site analysis and exempt-quantity radioactive check sources are packaged and shipped in accordance with DOT regulations via commercial carriers.

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## 7. REFERENCES

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AEC (Atomic Energy Commission). 1974. Regulatory Guide 1.86. Termination of Operating Licenses for Nuclear Reactors. June.

NRC (U.S. Nuclear Regulatory Commission). 1996. Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Radiation Exposure*, Revision 1, Washington, DC. February.

———. 1999. Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure*, Revision 3, Washington, DC. June.

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**Appendix A**  
**Radiation Protection Plan**  
**Acknowledgment Form**

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# RADIATION PROTECTION PLAN ACKNOWLEDGMENT FORM

I have reviewed, understand, and agree to follow the Radiation Protection Plan. Additionally, I understand that there are additional nonradiological health and safety requirements, which are presented in the Site Safety and Health Plan. I agree to abide by the requirements of the Radiation Protection Plan for the work that I will perform.

[illegible]

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### **ATTACHMENT 3**

## **SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND QUALITY ASSURANCE PLAN) FOR BASEWIDE RADIOLOGICAL SURVEYS**



**Draft**

**Sampling and Analysis Plan  
(Field Sampling Plan and Quality Assurance)  
for Basewide Radiological Surveys**

**Naval Air Station Joint Reserve Base  
Willow Grove  
Willow Grove, Pennsylvania**

**August 2013**

Prepared for:

**Department of the Navy  
Base Realignment and Closure  
Program Management Office East  
Philadelphia, Pennsylvania**

Prepared by:

**Tetra Tech, Inc.  
661 Anderson Drive, Suite 5  
Pittsburgh, Pennsylvania**

Prepared under:

**Naval Facilities Engineering Command  
Contract Number N62470-08-D-1001  
Contract Task Order WE42**

Contract Number N62470-08-D-1001  
Contract Task Order WE42

## SAP WORKSHEET #1 – TITLE AND APPROVAL PAGE

**DRAFT**  
**SAMPLING AND ANALYSIS PLAN**  
**(Field Sampling Plan and Quality Assurance Project Plan)**

**BASEWIDE RADIOLOGICAL SURVEYS**  
**NAVAL AIR STATION JOINT RESERVE BASE WILLOW GROVE**  
**WILLOW GROVE, PENNSYLVANIA**

**August 2013**

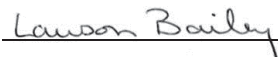
**Prepared for:**  
Department of the Navy  
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Philadelphia, Pennsylvania

**Prepared by:**  
Tetra Tech, Inc.  
661 Anderson Drive, Suite 5  
Pittsburgh, Pennsylvania

**Prepared under:**  
Naval Facilities Engineering Command  
Contract Number N62470-08-D-1001  
Contract Task Order WE42

### Review Signatures:

Lawson Bailey  
Project Manager  
Tetra Tech, Inc.



Tom Johnston  
Quality Assurance Manager  
Tetra Tech, Inc.



### Approval Signatures:

Brian Helland  
Remedial Project Manager  
NAVFAC MIDLANT

**HELLAND.BRIA**  
**N.J.1231396710**  
Digitally signed by  
HELLAND.BRIAN.J.1231396710  
DN: c=US, o=U.S. Government, ou=DoD,  
ou=PKI, ou=USN,  
cn=HELLAND.BRIAN.J.1231396710  
Date: 2013.08.13 16:00:52 -04'00'

## EXECUTIVE SUMMARY

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This Sampling and Analysis Plan (SAP) was developed to support the Basewide Radiological Management Plan ([Tetra Tech 2013](#)) for Basewide Radiological Surveys at Naval Air Station (NAS) Joint Reserve Base (JRB) Willow Grove, Willow Grove, Pennsylvania. The SAP addresses the objectives, procedures, functional activities, and specific quality assurance and quality control activities associated with planned field activities in support of radiological surveys of potentially impacted buildings at NAS JRB Willow Grove. This document constitutes the planning document, addressing specific protocols for sample collection, sample handling and storage, chain-of-custody, laboratory and field analyses, data validation, and data reporting. The requirements of this SAP are applicable to all project personnel, project support groups, contractors, and subcontractors.

The overall project is being managed by Tetra Tech, Inc., as the prime contractor under Contract Number N62470-08-D-1001 with the Naval Facilities Engineering Command Mid-Atlantic (NAVFAC MIDLANT). Tetra Tech, Inc. (Tetra Tech) has prepared this SAP on behalf of the Base Realignment and Closure Program Management Office. This SAP complies with applicable Department of the Navy, Pennsylvania, and U.S. Environmental Protection Agency (EPA) Region 3 requirements, regulations, guidance and technical standards, especially EPA and U.S. Department of Defense (DoD), U.S. Department of Energy (DOE), and EPA ([2005](#)). To comply with DoD, DOE and EPA ([2005](#)) requirements, the SAP is presented in the format of standard worksheets specified in the Uniform Federal Policy Quality Assurance Project Plan.

Operations involving radioactive material were performed at NAS JRB Willow Grove from 1943 through 2011. All naval operations at NAS JRB Willow Grove officially terminated in September 2011. The Navy prepared a Historical Radiological Assessment (HRA) to identify potentially impacted sites at NAS JRB Willow Grove (Tetra Tech, Inc. [[Tetra Tech](#)] [2012](#)). The HRA ([Tetra Tech 2012](#)) identified an impacted site as a site that has, or historically had, a potential for General Radioactive Material contamination based on the site operating history or known contamination detected during previous radiation surveys. A designation of “impacted” does not confirm that radioactive contamination is present, only that the possibility exists and must be investigated.

The overall conclusion of the HRA ([Tetra Tech 2012](#)) was that low levels of radioactive contamination potentially exist within the confines of NAS JRB Willow Grove. The levels of radiation associated low level radioactive contamination potentially represent an unacceptable level of risk for certain receptors and exposures scenarios such as a resident living on site.

The scope for this project is to perform radiological surveys, in the form of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Scoping Surveys (Nuclear Regulatory Commission [[NRC](#)] [2000](#)), in parts of nine buildings and three Installation Restoration Program (IRP) sites to further characterize the radiation levels and exposure potential for various human receptors. Additional buildings may be added depending on the

approval of the HRA ([Tetra Tech 2012](#)). In addition, removal of contaminated materials may be recommended with the intent of reducing potentially unacceptable exposures to acceptable levels

The fifteen buildings and three IRP sites that will be surveyed during this project include the following:

- Building 4
- Building 18
- Building 20
- Building 22
- Building 23
- Building 29
- Building 77
- Building 80
- Building 118
- Building 140
- Building 175
- Building 177
- Bunker 180
- Bunker 601
- Bunker 680
- IR Site 1
- IR Site 3
- IR Site 12

The actions to be performed include the following:

- Scanning measurements
- Static measurements, as applicable
- Removable contamination measurements, as applicable
- Soil Sampling (IR sites)
- Floor drain sediment sampling (if necessary)
- Survey and removal of potentially contaminated floor tiles

Scanning and static measurements of building and site surfaces and systematic soil sampling at IR sites will be performed to determine if residual contamination is present in excess of the Derived Concentration Guideline Level (DCGL). Additionally, swipe samples of building surfaces will be collected to establish presence or absence of removable contamination and sediment samples from floor drains will be collected to determine if residual radioactive material is present in the drains. The results of these investigations are intended to provide technically sound and sufficient data and information to determine if the buildings can be radiologically free released or if further remedial actions are warranted. The site-specific survey requirements for addressing these measurements will be contained in the task specific plans (TSP). The TSPs are not a part of the SAP and will be prepared and approved by the Navy prior to performing field activities at buildings. A detailed description of the TSP process can be found in Section 3.3.1 of the management plan. The final evaluations could result in radiological free release of the potentially impacted areas, identification of contaminated areas for future remediation, or further investigations to more adequately characterize the nature and extent of contamination.

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## **ACRONYMS AND ABBREVIATIONS**

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%R	Percent recovery
AEC	United States Atomic Energy Commission
ANSI	American National Standards Institute
ATC	Air Traffic Control
BEC	BRAC Environmental Coordinator
BRAC	Base Realignment and Closure
CA	Corrective action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm <sup>2</sup>	Centimeters squared
Co-60	Cobalt 60
COC	Chain-of-custody
Cs-137	Cesium-137
CSO	Caretaker site office
DCGL	Derived concentration guideline level
DEP	Pennsylvania Department of Environmental Protection
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
dpm	Disintegrations per minute
DQA	Data Quality Assessment
DQI	Data quality indicator
DQO	Data quality objective
DU	Depleted uranium
EDD	Electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EPM	Environmental Program Manager
FedEx	Federal Express
ft <sup>2</sup>	Square feet
FSS	Final status survey
FTMR	Field task modification request
GEMD	Ground Electronic Maintenance Division
GFPC	Gas Flow Proportional Counter
GM	Geiger-Mueller
H-3	Tritium
HASP	Health and Safety Plan
HLRA	Horsham Land Redevelopment Authority

## ***ACRONYMS AND ABBREVIATIONS (CONTINUED)***

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HPGe	High Purity germanium
HRA	Historical Radiological Assessment
IDW	Investigation-derived waste
IRP	Installation Restoration Program
JPEG	Joint photographic experts group
JRB	Joint Reserve Base
LCS	Laboratory control sample
LLRW	Low level radioactive waste
M&E	Material and Equipment
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum detectable concentration
MDL	Method detection limit
MIDLANT	Mid-Atlantic
mL	Milliliter
MPC	Measurement performance criteria
mrem/y	Millirem per year
MS/MSD	Matrix spike/matrix spike duplicate
MSI	Millennium Services, Inc.
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NEDD	Navy electronic data deliverable
NFESC	Naval Facilities Engineering Service Center
NIRIS	Naval Installation Restoration Information Solution
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PAL	Project Action Limit
PARCC	Precision, accuracy, representativeness, completeness, and comparability
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
PHP	Project Health Physicist
PM	Project Manager
PMO	Program Management Office
PPE	Personal protective equipment
PQL	Project Quantitation Limit
PRSO	Project radiation safety officer

## **ACRONYMS AND ABBREVIATIONS (CONTINUED)**

---

QA	Quality assurance
QAM	Quality Assurance Manager or Quality Assessment Manual
QAPP	Quality assurance project plan
QC	Quality control
QCSR	Quality Control Summary Report
QL	Quantitation limit
QSM	Quality Systems Manual
Ra-226	Radium 226
RASO	Radiological Affairs Support Office
RCRA	Resource Conservation and Recovery Act
RE	Radiological Engineer
RL	Reference Limit
ROC	Radionuclide of concern
ROICC	Resident officer in charge of construction
RPD	Relative percent difference
RPM	Remedial Project Manager
RSOR	Radiation Safety Officer Representative
SAP	Sampling and analysis plan
SCM	Surface contamination monitor
SD	Standard Deviation
SDG	Sample delivery group
SOP	Standard operating procedure
SOW	Statement of work
SPM	Subcontract Project Manager
Sr-90	Strontium 90
SS	Site Supervisor
SSO	Site Safety Officer
TBD	To be determined
Tetra Tech	Tetra Tech, Inc.
Th-232	Thorium 232
TSP	Task specific plan
U-238	Uranium 238
UFP	Uniform Federal Policy
UO <sup>2</sup>	Uranium oxide
USAEC	U.S. Atomic Energy Commission
WW	World War
y	Year

## SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION

(UFP-QAPP Manual Section 2.2.4)

**Site Name/Number:** Naval Air Station (NAS) Joint Reserve Base (JRB) Willow Grove  
**Operable Unit:** Basewide  
**Contractor Name:** Tetra Tech, Inc.  
**Contract Number:** N62470-08-D-1001  
**Contract Title:** Comprehensive Long-Term Environmental Action Navy (CLEAN)  
**Contract Task Order:** WE42

1. This sampling and analysis plan (SAP) was prepared in accordance with the requirements of the Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP) (U.S. Environmental Protection Agency [EPA] 2005) and EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (EPA 2002).
2. Identify regulatory program: CERCLA
3. Identify Approval Entity: Naval Facilities Engineering Command Mid-Atlantic (NAVFAC MIDLANT)
4. This SAP is a project-specific SAP.

List dates of scoping sessions that were held:

SCOPING SESSION	DATE
Teleconference with BRAC PMO NE and Radiological Affairs Support Office (RASO)	2/15/13

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

TITLE	DATE
No SAP documents have been generated for previous site work.	

## **SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION (CONTINUED)**

6. List organizational partners (stakeholders) and connection with lead organization  
Radiological Affairs Support Office (RASO), Supporting Organization (lead agency stakeholder)  
Base Realignment and Closure (BRAC) Program Management Office (PMO) East, Supporting Organization (lead agency stakeholder)  
U.S. Environmental Protection Agency, Region III (EPA) (regulatory stakeholder)  
Pennsylvania Department of Environmental Protection (DEP) (regulatory stakeholder)  
Horsham Land Redevelopment Authority (HLRA) (stakeholder)
7. Lead organization  
  
NAVFAC MIDLANT
8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

## SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION (CONTINUED)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
<b>A. Project Management</b>		
<i>Documentation</i>		
1	Title and Approval Page	
2	Table of Contents SAP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
<i>Project Organization</i>		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	
<i>Project Planning/ Problem Definition</i>		
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background Site Maps (historical and present)	
11	Site-Specific Data Quality Objectives	
12	Measurement Performance Criteria (MPC) Table	
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	Not applicable; No secondary data used in developing this SAP
14	Summary of Project Tasks	
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
<b>B. Measurement Data Acquisition</b>		
<i>Sampling Tasks</i>		
17	Sampling Design and Rationale	
18	Sampling Locations and Methods/ Standard Operating Procedure (SOP) Requirements Table Sample Location Map(s)	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	

## SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION (CONTINUED)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
<i>Analytical Tasks</i>		
23	Analytical SOPs Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	
<i>Sample Collection</i>		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	
<i>Quality Control Samples</i>		
28	Quality Control (QC) Samples Table Screening/Confirmatory Analysis Decision Tree	
<i>Data Management Tasks</i>		
29	Project Documents and Records Table	
30	Analytical Services Table Analytical and Data Management SOPs	
<b>C. Assessment Oversight</b>		
31	Planned Project Assessments Table Audit Checklists	
32	Assessment Findings and Corrective Action Responses Table	
33	Quality Assurance (QA) Management Reports Table	
<b>D. Data Review</b>		
34	Verification (Step I) Process Table	
35	Validation (Steps IIa and IIb) Process Table	
36	Validation (Steps IIa and IIb) Summary Table	
37	Usability Assessment	

**SAP WORKSHEET #3 – DISTRIBUTION LIST**  
 (UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Willington Lin	BRAC Environmental Coordinator	BRAC PMO East	215-897-4904	<a href="mailto:willie.lin@navy.mil">willie.lin@navy.mil</a>
Brian Helland	Navy Remedial Project Manager (RPM)	BRAC PMO East	215-897-4912	<a href="mailto:brian.helland@navy.mil">brian.helland@navy.mil</a>
Patrick Owens	Environmental Program Manager (EPM)	Naval Sea Systems Command Detachment, RASO	757-887-7644	<a href="mailto:patrick.a.owens@navy.mil">patrick.a.owens@navy.mil</a>
Martin Schy	Caretaker Site Officer (CSO)	BRAC PMO East	215-293-4888	<a href="mailto:martin.schy@navy.mil">martin.schy@navy.mil</a>
Lisa Cunningham	RPM	EPA	215-814-3363	<a href="mailto:cunningham.lisa@epa.gov">cunningham.lisa@epa.gov</a>
Margaret Pollich	Project Officer	PADEP	484-250-5731	<a href="mailto:mpollich@pa.gov">mpollich@pa.gov</a>
TBD	Radiation Program Manager	PADEP-BRP	TBD	TBD
Lawson Bailey	Project Manager (PM)/Project Health Physicist (PHP)/Radiation Safety Officer Representative (RSOR)/ Site Safety Officer (SSO)	Tetra Tech	803-641-6326	<a href="mailto:lawson.bailey@tetrattech.com">lawson.bailey@tetrattech.com</a>
Dick Dubiel	Subcontract Project Manager (SPM)/ Radiological Engineer (RE)	Millennium	678-296-4813	<a href="mailto:ddubiel@millserv.com">ddubiel@millserv.com</a>
TBD	Site Supervisor (SS)	Millennium	TBD	TBD
Heather Shaffer	Laboratory PM	GEL	843-556-8171	<a href="mailto:heather.shaffer@gel.com">heather.shaffer@gel.com</a>
Joe Samchuck	Data Validation	Tetra Tech	412-921-8510	<a href="mailto:joseph.samchuck@tetrattech.com">joseph.samchuck@tetrattech.com</a>
Erik Abkemeier	Project Radiation Safety Officer (PRSO)	Tetra Tech	757-466-4906	<a href="mailto:erik.abkemeier@tetrattech.com">erik.abkemeier@tetrattech.com</a>

### SAP WORKSHEET #3 – DISTRIBUTION LIST (CONTINUED)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Tom Johnston (electronic copy)	Quality Assurance Manager (QAM)	Tetra Tech	412-921-8615	<a href="mailto:tom.johnston@tetrattech.com">tom.johnston@tetrattech.com</a>

Notes:

BRAC	Base Realignment and Closure	PRSO	Project Radiation Safety Officer
CSO	Caretaker Site Officer	QAM	Quality Assurance Manager
EPA	Environmental Protection Agency	RASO	Radiological Affairs Support Office
EPM	Environmental Program Manager	RE	Radiological Engineer
NAVFAC MIDLANT	Naval Facilities Engineering Command Mid-Atlantic	RPM	Remedial Project Manager
PADEP	Pennsylvania Department of Environmental Protection	SPM	Subcontract Project Manager
PHP	Project Health Physicist	SS	Site Supervisor
PM	Project Manager or Program Manager	SSO	Site Safety Officer
PMO	Program Management Office		

## SAP WORKSHEET #4 – PROJECT PERSONNEL SIGN-OFF SHEET

(UFP-QAPP Manual Section 2.3.2)

The Project Personnel Sign-off Sheet documents that all key project personnel performing work have read this site-specific SAP and will carry out the tasks as described. The sign-off sheet, which will be included in the central project file, will be signed by all on-site personnel after they read the SAP. However, if only a portion of the SAP was reviewed, then personnel will note which sections were reviewed on the sign-off sheet.

Name	Organization Title/Role	Telephone Number (optional)	Signature/e-mail receipt	SAP Section Reviewed	Date SAP Read
Brian Helland	Navy, RPM/ Manages project activities for the Navy	215-897-4912		All	
Margaret Pollich	PADEP, PO/Provides regulator input	484-250-5731		All	
Lawson Bailey	Tetra Tech, PM/ Manages project activities	803-641-6326	See <a href="#">Worksheet #1</a> for signature	All	
Lawson Bailey	Tetra Tech, PHP/ Designated overview of health physics activities	803-641-6326	See <a href="#">Worksheet #1</a> for signature	All	
Erik Abkemeier	Tetra Tech, PRSO/ Manages project safety and required licenses	757-466-4906		All	
Tom Johnston	Tetra Tech CLEAN QAM/ Manager NAVFAC LANT Contract QA Program and Implementation	412-921-8615	See <a href="#">Worksheet #1</a> for signature	All	
Dick Dubiel	Millennium - SPM/RE	678-296-4813		All	
TBD	Millennium - SS	TBD		All	
Lawson Bailey	Site Safety Officer (SSO)	803-641-6326	See <a href="#">Worksheet #1</a> for signature	All	
Kelly Carper	Tetra Tech, Project Chemist/ Provides coordination with laboratories	412-921-7273		All	

## SAP WORKSHEET #4 – PROJECT PERSONNEL SIGN-OFF SHEET (CONTINUED)

Name	Organization Title/Role	Telephone Number (optional)	Signature/e-mail receipt	SAP Section Reviewed	Date SAP Read
Heather Schaffer	GE:, Laboratory PM/ Representative for laboratory and analytical issues	843-769-7386		Worksheets 11, 12, 15, 19, 20, 23, 24, 25, 28, 30, 34, 35, 36, and 37	
Joe Samchuck	Data Validation Manager/ Manages Data Validation	412-921-8510		Worksheets 11, 12, 15, 19, 20, 23, 24, 25, 28, 30, 34, 35, 36, and 37	

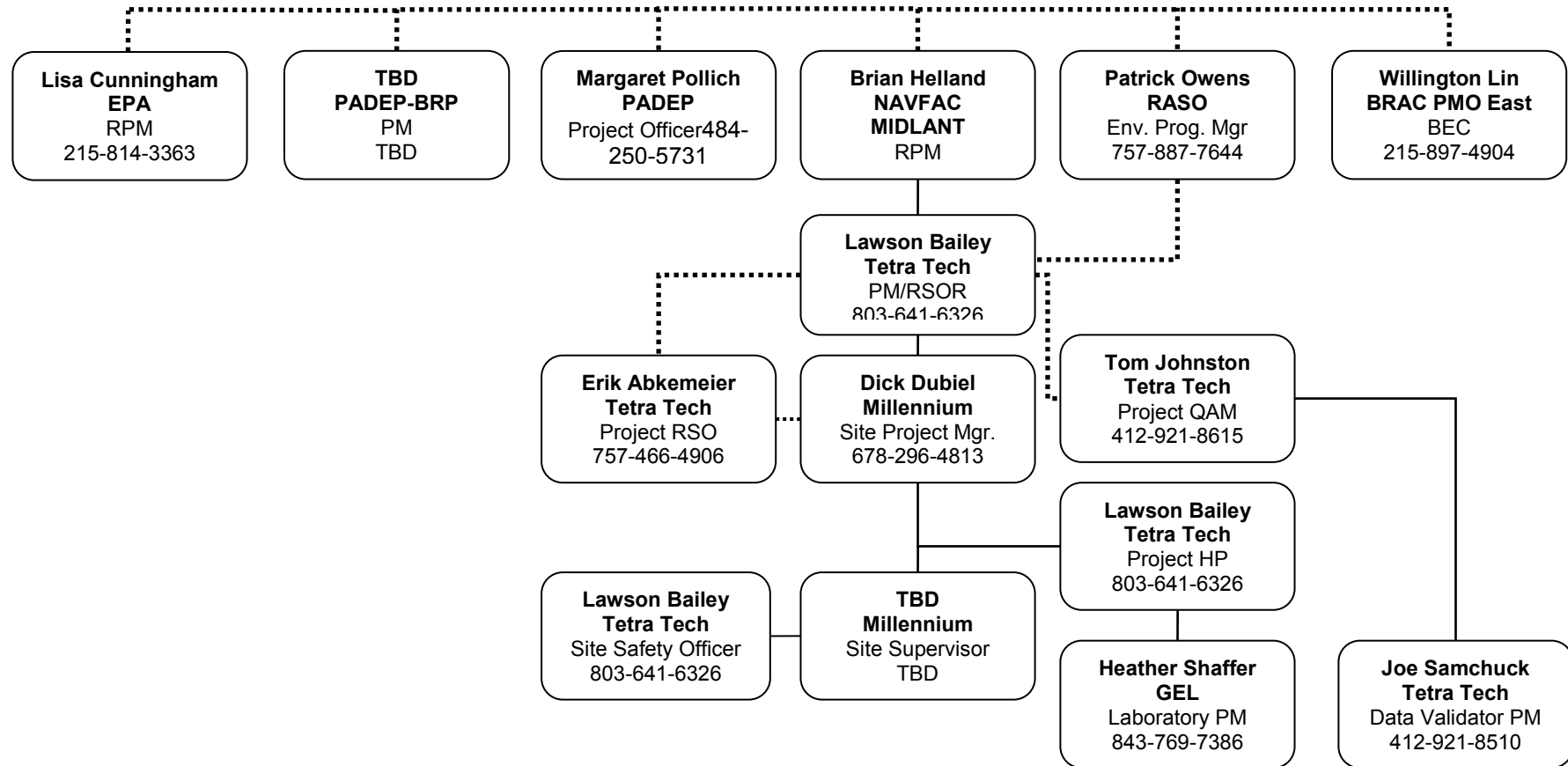
Notes:

PHP Project Health Physicist  
PO Project Officer  
PRSO Project Radiation Safety Officer  
PM Project Manager

QAM Quality Assurance Manager  
RE Radiological Engineer  
SPM Subcontract Project Manager  
SS Site Supervisor

## SAP WORKSHEET #5 – PROJECT ORGANIZATIONAL CHART

(UFP-QAPP Manual Section 2.4.1)



Lines of Authority —————

Lines of Communication .....

## SAP WORKSHEET #6 – COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Notice to proceed	Navy RPM	Brian Helland	215-897-4912	Navy RPM will review and approve project management plans, and communicate directly with contractor on all aspects of project management. Navy RPM will also coordinate with appropriate personnel in the event that changes require additional approvals or authorizations within 7 business days (letter of notice to proceed or via e-mail).
Coordination of off-site laboratory services	PHP Laboratory PM	Lawson Bailey TBD	803-641-6326 TBD	The PHP or designee will coordinate all activities requiring off-site laboratory support, including, delivery of necessary sample containers and appropriate shipping materials (such as coolers and bubble wrap) on site prior to commencement of field sampling activities and within 24-48 hours after each sampling event (verbally or via e-mail to the Laboratory PM).
Field and analytical corrective actions	QAM PM Navy RPM	Tom Johnston Lawson Bailey Brian Helland	412-921-8615 803-641-6326 215-897-4912	The Tetra Tech QAM will notify the PM verbally or by e-mail within one business day that the corrective action has been completed.  The PM will then notify the Navy RPM within one business day.
Field task modification requests (FTMR)	SS	TBD	TBD	The SS will document the change via an FTMR form within two days of identifying the need for change and will obtain required approvals within five days of initiating the form.
SAP amendments	PM SPM Navy RPM RASO	Lawson Bailey Dick Dubiel Brian Helland Patrick Owens	803-641-6326 678-296-4813 215-897-4912 757-887-7644	The SPM will verbally inform the PM within 24 hours of realizing a need for an amendment.  The PM will document the proposed changes via a Field Task Modification Request (FTMR) form within five days and send the Navy RPM a concurrence letter within seven days of identifying the need for change.  SAP amendments will be submitted by the PM to the Navy RPM for review and approval.

## SAP WORKSHEET #6 – COMMUNICATION PATHWAYS (CONTINUED)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
				RASO concurrence required on all SAP amendments.  The PM will send scope changes to the Project Team via e-mail within one business day.
Changes in schedule	PM SPM	Lawson Bailey Dick Dubiel	803-641-6326 678-296-4813	The PM will verbally inform the Navy RPM on the day that schedule change is known and document via schedule impact letter within one business day of when impact is realized.
Issues in the field that result in changes in scope	SPM PM Navy RPM RASO	Lawson Bailey Dick Dubiel Brian Helland Patrick Owens	803-641-6326 678-296-4813 215-897-4912 757-887-7644	The SPM will verbally inform the PM on the day that the issue is discovered.  The PM will inform the Navy RPM (verbally or via e-mail) within one business day of discovery.  The Navy RPM will issue scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed.  The PM will document the change via an FTMR form within two days of identifying the need for change and will obtain required approvals within five days of initiating the form.  RASO must concur, via e-mail or verbal communication, on all radiological changes in scope.
Recommendations to stop work <sup>1</sup> and initiate work upon corrective action	SS SSO PM Tetra Tech QAM SPM Navy RPM	TBD Lawson Bailey Lawson Bailey Tom Johnston Dick Dubiel Brian Helland	860-844-4430 803-641-6326 803-641-6326 412-921-8615 678-296-4813 215-897-4912	If Tetra Tech is the responsible party for a stop work command, the SS will inform onsite personnel, subcontractor(s) and the identified Project Team members within one hour (verbally or by e-mail).  If a subcontractor is the responsible party, the subcontractor PM must inform the SS within 15 minutes, and the SS will then follow the procedure listed above.
Analytical data quality issues	Laboratory PM Tetra Tech Project Chemist	Heather Shaffer Kelly Carper	843-769-7386 412-921-7273	The Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within one business day of when an issue related to laboratory data is discovered.

## SAP WORKSHEET #6 – COMMUNICATION PATHWAYS (CONTINUED)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
				<p>The Tetra Tech Project Chemist will notify (verbally or via e-mail) the data validation staff and the PM within one business day.</p> <p>The Tetra Tech PM will notify the Navy RPM (verbally or via e-mail) of significant data quality issues within 1 business day of resolution.</p>
Review of analytical data and concurrence on radiological actions	RASO PM	Patrick Owens Lawson Bailey	757-887-7644 803-641-6326	<p>The PM will then notify the Navy RPM within one business day that data is available for review.</p> <p>RASO will verify concurrence of radiological actions within one business (via e-mail).</p>
SAP procedure revision during field activities	SPM PM	Dick Dubiel Lawson Bailey	678-296-4813 803-641-6326	The PM will then notify the Navy RPM within one business day.

Notes:

- 1 All site personnel have the ability to stop work if they deem that unsafe conditions exist or if procedural guidance is being exceeded.

FTMR Field Task Modification Request  
 PHP Project Health Physicist  
 PM Project Manager  
 QA/QC Quality Assurance/Quality Control  
 RASO Radiological Affairs Support Office

RE Radiological Engineer  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager  
 SS Site Supervisor  
 SSO Site Safety Officer

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Patrick Owens	EPM	RASO	<ul style="list-style-type: none"> <li>Provides government oversight of the QA program, including review and sign-off on SAPs and any future modifications to the plans</li> <li>Provides quality-related direction to the Navy RPM and the Tetra Tech QAM</li> <li>Has authority to suspend affected project or site activities if approved quality requirements are not adequately met</li> <li>Reviewing radiological laboratory and field survey data on a routine basis</li> <li>Performing on-site reviews of all radiological site operations</li> <li>Reviewing and approving TSPs and final status survey reports</li> <li>Performing quality reviews on radionuclides of concern (ROC) to ensure samples are handled in accordance with the management plan and SAP</li> <li>Providing review and concurrence on data for proposed radiological actions</li> <li>Ensuring that all necessary sample results are provided and are consistent with proposed radiological actions</li> <li>Comparing radiological data with the requirements of the management plan, SAP, and TSPs, to ensure that all proper conditions have been met to implement the action requested</li> <li>Ensuring that the radiological data reported is consistent with the intent for which the data was provided</li> <li>Comparing the sample number matrix with the intent of the data package to ensure that the sample number is consistent with the intent of the data package</li> <li>Reviewing sample acquisition information to ensure that the duration the sample was analyzed for meets the minimum required time necessary to meet the minimum detectable concentration (MDC)</li> <li>Comparing each of the radionuclides' specific activity with the release criteria to ensure that the decision made is consistent with the specific activity reported</li> <li>Comparing the MDC with the release criteria to ensure that it is below the release levels</li> <li>Evaluating the qualifiers provided in the sample results to ensure that the information provided is consistent with the results provided</li> <li>Reviewing uncertainty counting and the 2 sigma total uncertainty data along with the laboratory qualifiers to determine if the data can be used</li> </ul>
Brian Helland	Navy RPM	BRAC PMO E	<ul style="list-style-type: none"> <li>Performing project management for the Navy</li> <li>Ensuring that the project scope of work requirements are fulfilled</li> <li>Overseeing the project cost and schedule</li> <li>Providing formal technical direction to the contractor project team, as needed</li> <li>Acting as lead interface with agencies</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
Lawson Bailey	PM	Tetra Tech	<ul style="list-style-type: none"> <li>Coordinating work activities of contractor and subcontractor personnel and ensuring that all personnel adhere to the administrative and technical requirements of the project</li> <li>Monitoring and reporting the progress of work and ensuring that the project deliverables are completed on time and within project budget</li> <li>Monitoring the budget and schedule and notifying the client and the RPM of any changes that may require administration actions</li> <li>Ensuring adherence to the quality requirements of the contract, project scope of work, and the SAP</li> <li>Ensuring that all work meets the technical requirements of task specific plans (TSPs) and complies with applicable codes and regulations</li> <li>Ensuring that all work activities are conducted in a safe manner in accordance with the Site Health and Safety (HASP) and all applicable Occupational Safety and Health Administration (OSHA) regulations</li> <li>Serving as the primary contact between the Navy and Tetra Tech for actions and information related to the work and including appropriate Tetra Tech or subcontractor personnel in the decision making</li> </ul>
Dick Dubiel	SPM	Millennium	<ul style="list-style-type: none"> <li>Responsible for technical direction to the onsite organization regarding data collection methodology</li> <li>Responsible to ensure adequate resources are provided to implement this management plan and TSPs</li> <li>Works directly with the SS and RE during implementation of on-site activities.</li> <li>Responsible for the quality review of data generated from field activities. The quality review can be delegated, provided it is delegated to an individual who has not been directly involved in the generation or processing of the field data.</li> <li>Responsible for communicating directly with the PM regarding field issues including schedule adherence, survey results and quality issues</li> <li>If changes are necessary, the SPM is responsible for communicating the changes via phone and/or e-mail to project staffs and is authorized to stop work if necessary.</li> <li>Inform Navy via schedule impact letter as soon as impact is realized and scope identified.</li> <li>Responsible for the preparation of FTMR for any changes in project procedures that occur due to conditions in the field.</li> <li>Assists in the performance of field sampling system audits</li> <li>Prepares field data validation report (weekly)</li> <li>Prepares Project monthly progress report</li> <li>Reviews weekly and verifies that the field logbook information is complete</li> <li>Assists in the review of laboratory data</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
Lawson Bailey	Project Health Physicist (PHP)	Tetra Tech	<ul style="list-style-type: none"> <li>Assisting in the development and approval of the management plan, SAP, TSPs and HASP</li> <li>Assisting in identifying radiological analysis needs</li> <li>Providing technical support for field activities</li> <li>Providing health physics guidance on an as-needed basis</li> <li>Providing radiological control protection services, if required</li> <li>Directing and assisting project personnel in proper completion of radiological records</li> <li>Reviewing and approving project field procedures that involve the handling of radioactive materials or access to radiological areas</li> <li>Conducting radiation incident investigations</li> <li>Conducting radiological project inspections</li> <li>Evaluating and selecting a qualified off-site laboratory</li> <li>Coordinating with analytical laboratory and data validator to assure proper implementation of SAP requirements</li> <li>Reviewing off-site laboratory data against requirements in this SAP prior to use</li> <li>Assessing off-site data to ensure that the quality of the data meets the intended use of the data</li> </ul>
Erik Abkemeier	PRSO	Tetra Tech	<ul style="list-style-type: none"> <li>Overseeing overall radiological operations</li> <li>Ensuring that all radiological operations are performed in accordance with Tetra Tech's Nuclear Regulatory Commission (NRC) Materials License #29-31396-01, as amended</li> </ul>
Tom Johnston	QAM	Tetra Tech	<ul style="list-style-type: none"> <li>Establishing and maintaining the QA program</li> <li>Acting as a focal point for coordination for quality matters concerning project analysis</li> <li>Suspending project activities if quality standards are not maintained</li> <li>Interfacing with the Navy, including RASO, on quality-related items</li> <li>Performing reviews of audit and surveillance reports conducted by others</li> <li>Implementing Navy technical direction letters related to quality topics</li> <li>Verifying that data collection methods specified in the SAP comply with Navy and Tetra Tech requirements</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
TBD	SS	Millennium	<ul style="list-style-type: none"> <li>• Providing day-to-day technical and administrative oversight of radiological operations</li> <li>• Reviewing scan and static survey data prior to it being sent to the RE</li> <li>• Ensuring that all radiological instrumentation is functioning properly</li> <li>• Performing sampling activities as directed by the management plan, SAP, and TSPs</li> <li>• Ensuring that field supplies are available on site</li> <li>• Identify Issues in the field that result in changes in scope</li> <li>• Provide applicable training to Survey Team members</li> <li>• Maintain project documentation</li> <li>• Assign sample numbers (along with RE) as sample locations are identified</li> <li>• Responsible for the care and custody of collected samples</li> <li>• Generates weekly status reports</li> <li>• Generates Field Task Modification Requests, as required</li> <li>• Performs field sampling system audits</li> </ul>
Dick Dubiel	RE	Millennium	<ul style="list-style-type: none"> <li>• Implementing the management plan, SAP, and TSPs</li> <li>• Ensuring that field personnel have documented training on survey and sampling procedures for specific project requirements</li> <li>• Assisting HP in review of off-site laboratory data against requirements in this SAP prior to use</li> <li>• Identification and implementation of field and analytical corrective actions and verification of corrective action effectiveness</li> <li>• Assists SS in conducting field sampling system audits</li> <li>• Assisting SS in assigning field sample numbers</li> <li>• Reviews field and laboratory data to assess quality control</li> </ul>
Lawson Bailey	SSO	Tetra Tech	<ul style="list-style-type: none"> <li>• Oversees site safety</li> <li>• Implements requirements of HASP and all applicable OSHA workplace safety standards</li> <li>• Responsible for implementing appropriate site control measures and personal protection levels</li> <li>• Conducts safety briefings for site personnel and site visitors</li> <li>• Can suspend operations that threaten health and safety</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
Heather Shaffer	Laboratory PM	GEL	<ul style="list-style-type: none"> <li>Reviewing laboratory sample results</li> <li>Implementing laboratory SOPs</li> <li>Overseeing performance of gamma spectroscopy, strontium 90 (Sr-90), Tritium (H-3) and alpha spectroscopy analyses</li> <li>Ensuring that all laboratory instrumentation is properly maintained and calibrated, as necessary</li> <li>Reviewing gamma spectroscopy analytical result reports to ensure that the MDCs are below the release criteria, that the counting uncertainties are within tolerance of the reported activity, and that the flags associated with each report represent a clear understanding of the associated reported activity for the isotope in question</li> <li>Verifying each analytical result by reviewing the spectrum file associated with each report</li> <li>Ensuring that the electronic and hard copies of the analytical summary reports are delivered to the contractor for review</li> </ul>
Joe Samchuck	Data Validator	Tetra Tech	<ul style="list-style-type: none"> <li>Perform independent data validation of all laboratory generated data.</li> </ul>

Notes:

BRAC Base Realignment and Closure  
 EPM Environmental Project Manager  
 FTMR Field Task Modification Request  
 HASP Health and Safety Plan  
 MDC Minimum Detectable Concentration  
 NRC Nuclear Regulatory Commission  
 OSHA Occupational Safety and Health Administration  
 PHP Project Health Physicist  
 PM Project Manager  
 PMO Project Management Office  
 PRSO Project Radiation Safety Officer

QA Quality Assurance  
 QAM Quality Assurance Manager  
 RASO Radiological Affairs Support Office  
 RE Radiological Engineer  
 ROC Radionuclide of Concern  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager  
 SAP Sampling and Analysis Plan  
 SOP Standard Operating Procedure  
 SS Site Supervisor  
 TSP Task Specific Plan

**SAP WORKSHEET #8 – SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE**  
(UFP-QAPP Manual Section 2.4.4)

Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates <sup>1</sup>
Radiation Awareness Training	SS	TBD	Survey Team/Subcontractors	SS, RE and SSO will be responsible for the field training	Documentation of special training requirements will be maintained at the site by the SS
Surface contamination monitor (SCM) Operations	SS		Survey Team		
Portable and Fixed Instrument Training	SS		Survey Team		
Radiological Sampling	SS		Survey Team		
Project SOPs	SS		Survey Team		

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response (HAZWOPER) training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 (e). Project-specific safety requirements are addressed in greater detail in the site-specific HASP.

CFR Code of Federal Regulations  
HASP Health and Safety Plan  
OSHA Occupational Safety and Health Administration  
RE Radiological Engineer

SCM Surface Contamination Monitor  
SOP Standard Operating Procedure  
SS Site Supervisor  
SSO Site Safety Officer

## SAP WORKSHEET #9 – PROJECT SCOPING SESSION PARTICIPANTS SHEET

(UFP-QAPP Manual Section 2.5.1)

<b>Project Name:</b> Basewide Radiological Surveys <b>Projected Date(s) of Sampling:</b> TBD <b>Project Manager:</b> Lawson Bailey, Tetra Tech		<b>Site Name:</b> NAS JRB Willow Grove <b>Site Location:</b> Willow Grove, Pennsylvania		
<b>Date of Session:</b> 2/15/13 <b>Scoping Session Purpose:</b> Discussion of Former NAS JRB Willow Grove Radiological Program				
Name	Title/Role	Affiliation	Phone No.	E-mail Address
Willington Lin	BRAC Environmental Coordinator	BRAC PMO E	215-897-4904	<a href="mailto:willie.lin@navy.mil">willie.lin@navy.mil</a>
Todd Bober	Navy RPM	BRAC PMO NE	215-897-4911	<a href="mailto:todd.bober@navy.mil">todd.bober@navy.mil</a>
Steve Doremus	Director, EP Programs	RASO	757-887-7745	<a href="mailto:steve.doremus@navy.mil">steve.doremus@navy.mil</a>
Laurie Lowman	Lead Environmental Program Manager	RASO	757-887-7650	<a href="mailto:laurie.lowman@navy.mil">laurie.lowman@navy.mil</a>
Patrick Owens	Environmental Program Manager	RASO	757-887-7644	<a href="mailto:patrick.a.owens@navy.mil">patrick.a.owens@navy.mil</a>
Lawson Bailey	PM/PHP	Tetra Tech	803-641-6326	<a href="mailto:lawson.bailey@tetrattech.com">lawson.bailey@tetrattech.com</a>
Amy Stanford	Health Physicist	Tetra Tech	803-641-6328	<a href="mailto:amy.stanford@tetrattech.com">amy.stanford@tetrattech.com</a>
Garth Glenn	Dep. Program manager	Tetra Tech	757-461-3926	<a href="mailto:garth.glenn@tetrattech.com">garth.glenn@tetrattech.com</a>

Comments/Decisions: General approach to scoping surveys of outdoor areas. Outstanding items required for initiating building surveys. Initial discussion of survey requirements and field implementation were discussed.

Notes:

BRAC Base Realignment and Closure  
 NE Northeast  
 PHP Project Health Physicist  
 PM Project Manager

PMO Program Management Office  
 RASO Radiological Affairs Support Office  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager

## **SAP WORKSHEET #10 – PROBLEM DEFINITION**

(UFP-QAPP Manual Section 2.5.2)

### **10.1 SITE DESCRIPTION**

The U.S Navy property known as NAS JRB Willow Grove consists of approximately 1,100 acres in southeastern Pennsylvania. The Main Station is located in Horsham Township and lies in the east-central portion of Montgomery County, immediately adjacent to Bucks County. The Main Station is located on gently rolling terrain with elevations ranging from 240 feet above mean sea level (AMSL) to 360 feet AMSL. The Main Station is bounded by State Route 611 toward the east, Horsham Road to the southwest, Keith Valley Road to the north, and County Line Road to the northeast. Entrance to the Station is gained through the main gate located on State Route 611.

NAS JRB Willow Grove includes a Main Station and two remote housing areas, the Shenandoah Woods and Jacksonville Road Housing areas. The Shenandoah Woods Housing Area is approximately 4.5 miles east of the Main Station and encompasses 51 acres in Warminster Township, Bucks County, Pennsylvania. The Jacksonville Road Housing Area is located in the Borough of Ivyland, Bucks County, Pennsylvania. It encompasses 2.5 acres and is approximately 3.5 miles east of the Main Station. The housing areas are not part of this plan.

The original land consisting of NAS JRB Willow Grove was acquired by the Navy in 1942 from Harold Pitcairn and was formally commissioned NAS Willow Grove in July 1943. In 1957, the Navy purchased additional land bordering the Station to bring the total land area of the Station to approximately 1,100 acres. In 1994, the Station's name was changed to Naval Air Station Joint Reserve Base, Willow Grove, to more accurately reflect the mission of the Station, which at that time supported the Navy, Marine Corps, and Air Force, Army Reserve and Pennsylvania Air National Guard.

Details of the radiological history of NAS JRB Willow Grove are provided in Section 6.0 of the HRA ([Tetra Tech 2012](#)). Historical radiological operations relevant to activities proposed for this project included the following:

- Overhaul and repair of aircraft instruments containing radium-226 (Ra-226) painted components;
- Maintenance, and storage of - depleted uranium (mostly uranium-238 [U-238]) counterweights;
- Use and storage of electron tubes that contained cobalt 60 (Co-60) and thorium 232 (Th-232);
- Use and storage of self-illuminating signs and aircraft lights that contained tritium (H-3);

## **SAP WORKSHEET #10 – PROBLEM DEFINITION (CONTINUED)**

- Use and storage of aircraft detector probes, pressure indicators, helicopter blade inspection systems, and personnel markers that contained and strontium 90 (Sr-90);
- Use and storage of spark-gap irradiators that contained cesium 137 (Cs-137), uranium oxide (UO<sub>2</sub>), or Co-60;
- Use and storage of night vision devices, turret assemblies, and aircraft gear boxes that contained Th-232.
- Disposal of Ra-226 contaminated liquids via the storm and sanitary drain system; and
- Disposal of radioactive material (all isotopes) in landfills; such as IRP Sites 1, 3 and 12.

### **10.2 PROBLEM DEFINITION**

#### **STEP 1: State the Problem**

The HRA ([Tetra Tech 2012](#)) has identified the potential presence of radionuclides exceeding unrestricted radiological release criteria for building surfaces, outdoor surfaces and soils, materials, and equipment at numerous sites at NAS JRB Willow Grove. A complete list of the areas included in this SAP is listed on Table 10-1 below. Buildings within the scope of this SAP have been categorized as Class 1, 2 or 3, using the definitions found in Multi-Agency Radiological Survey and Site Investigation Manual (MARSSIM) guidelines (Nuclear Regulatory Commission [[NRC](#)] 2000), based on the potential for residual contamination as determined in the HRA ([Tetra Tech 2012](#)).

## SAP WORKSHEET #10 – PROBLEM DEFINITION (CONTINUED)

**TABLE 10-1: POTENTIALLY IMPACTED SITES AND INVESTIGATION PARAMETERS**

Site	Sub Site	Contaminant(s)	Media	HRA Recommendation	Former Uses
4	Footprint of demolished building – 1,680 m <sup>2</sup>	Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Training Instruction Building
18	Footprint of demolished building – 266 m <sup>2</sup>	Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Operations and Control Tower
20	Footprint of demolished building – 1,535 m <sup>2</sup>	Sr-90, Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Old Aircraft Repair Hangar, Parachute and Survival Equipment Shop, AIMD, Avionics
22	Original structure and '70s addition – 1,579 m <sup>2</sup>	Sr-90, Ra-226	Structure, Fixtures and Concrete Slab	Scoping survey of impacted rooms	Aircraft Supply Warehouse
23	Footprint of demolished building – 1,535 m <sup>2</sup>	Sr-90, Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Parachute Shop
29	Interior of Building – 1,839 m <sup>2</sup>	Sr-90, Ra-226	Structure, Fixtures and Concrete Slab	Scoping survey of building	Aviation Supply and Station Weapons Building
77	Footprint of demolished building – 1,363 m <sup>2</sup>	Sr-90, Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Supply Dept., AIMD Paraloft
80	Interior of Hangar – 3,344 m <sup>2</sup> North Lean To – 641 m <sup>2</sup> South Lean To – 203 m <sup>2</sup>	H3, Sr-90, Ra-226, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	AIMD Maintenance Hangar
118	Shop and Storage Rooms – 42 m <sup>2</sup>	Sr-90, Ra-226	Structure, Fixtures and Concrete Slab	Scoping survey of building	Ground Electronic Maintenance Division (GEMD)
140	Shops and Labs – 376 m <sup>2</sup>	Ra-226	Structure, Fixtures	Scoping survey of building	ASW Training Facility, Avionics Training
175	Interior of Hangar – 30,359 m <sup>2</sup>	Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	VP Hangar

## SAP WORKSHEET #10 – PROBLEM DEFINITION (CONTINUED)

Site	Sub Site	Contaminant(s)	Media	HRA Recommendation	Former Uses
177	Interior of Hangar – 1,490 m <sup>2</sup>	Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	Army Aviation Support Facility (Hangar)
180	Avionics Shops - 865 m <sup>2</sup>	Sr-90, Ra-226, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	AIMD, Parachute Loft
601	Shops and Labs - 870 m <sup>2</sup>	H-3, Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	AIMD Training Facility
680	Interior of Hangar – 2,676 m <sup>2</sup> Shops - 111 m <sup>2</sup>	Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	Marine Hangar
Site 1	Footprint of landfill disposal trenches – 8,093 m <sup>2</sup>	Sr-90, Ra-226, U-238	Ground surface, surface soil	Scoping survey of known or suspected disposal areas	Privet Road Landfill
Site 3	Footprint of landfill disposal trenches – 32,421 m <sup>2</sup>	Sr-90, Ra-226, U-238	Ground surface, surface soil	Scoping survey of known or suspected disposal areas	North Street Landfill
Site 12	Footprint of landfill disposal trenches – 44,514 m <sup>2</sup>	Sr-90, Ra-226, U-238	Ground surface, surface soil	Scoping survey of known or suspected disposal areas	South Landfill

[Note: Additional buildings may be added depending on the approval of the Historical Site Assessment.]

Notes:

AIMD Aircraft Intermediate Maintenance Division  
 GEMD Ground Electronics Maintenance Division  
 H-3 Tritium  
 Ra-226 Radium 226

Sr-90 Strontium 90  
 U-238 Uranium 238  
 VP Patrol Squadron

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS**

(UFP-QAPP Manual Section 2.6.1)

### **STEP 2: Identify the Goal of the Study**

The decision at the former NAS JRB Willow Grove is to determine whether concentrations of radioactive materials on building surfaces within the scope of the management plan at NAS JRB Willow Grove exceed the specified release criteria (Table 6-1 of the management plan). If the concentrations of radioactive materials do exceed the specified release criteria, those surfaces or areas must be remediated along with additional surveys taken; otherwise the surfaces or areas may be recommended for free release or surface release with land use restrictions.

### **STEP 3: Identify Information Inputs**

The following physical and radiological data are needed to resolve the problem presented in [Section 10.2](#).

#### **Types of Radiological Testing**

The following types of scanning and static radiological measurement must be performed at each site.

- Walk-over scans
- Static scans
- Soil sampling
- Swipes (alpha, beta and H-3) for surface contamination
- Sediment sampling
- Offsite sample media analysis

#### **Survey and Sample Locations**

##### Reference Background Area

The reference area is a geographical area from which representative radioactivity measurements are performed for comparison with measurements performed in an impacted area. The reference area selected should have physical, chemical, radiological, and biological characteristics similar to the impacted area(s) being investigated. The reference area must not be identified as impacted by the HRA ([Tetra Tech 2012](#)). All on-site and off-site locations selected as reference areas will be approved by the RSO or RSOR. The same survey methods and equipment that will be used for conducting a survey in an impacted area will be used for the background area survey. Reference area data will normally be provided to the RSOR prior to the start of a survey.

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

### Building Surveys

Scanning and static radiological surface measurements must be performed at each site. Location data is dependent upon the method of survey or type of sample. The following records will be generated for each specific method of survey and type of sample.

- Individual computer-generated survey unit maps will be created for each walk-over survey. These maps include every detection for the surveyed area and are designated by x- and y- coordinates within the instrumentation.
- Visual markings on the surface will be created by the operator by the placement of instrumentation. The visual markings will be transcribed to radiation survey maps for every static survey that has a detection of radiation.
- Photographs and hand marked locations on building schematics to designate the location of every sediment sample. Sediment sample locations will be identified in the naming scheme for each laboratory sample generated.

### Land Surface Surveys

Scanning and static radiological surface measurements and soil sampling must be performed at each site. Location data is dependent upon the method of survey or type of sample. The following records will be generated for each specific method of survey and type of sample.

- Individual computer-generated survey unit maps will be created for each walk-over survey. These color coded maps will include gamma readings taken at two second intervals while traversing the survey unit. GPS coordinates will be collected but not reported on the survey map.
- Soil samples locations will be determined using a systematic triangular grid system. Visual markings on the surface will be created by the operator for each soil sampling location.

### **Radioactivity of the Radionuclides of Concern**

Radioactivity of each ROC listed in the HRA ([Tetra Tech 2012](#)) and summarized in Section 1.3. The radioactivity will be determined in accordance to the radiation survey methods discussed in [Worksheet #14](#) and in Section 5.0 of the management plan. In order to determine if the detections exceed unrestricted/free release or limited release criteria the maximum results must be compared to action levels.

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

### **Action Levels**

Action levels provide the point of comparison for determining whether free release or limited release of an area is possible. Action levels for each ROC are specified in Worksheet #15 and Section 6.0 of the management plan. The release criteria for each building of interest are based on the historical use of radioactive material in that building. Specific media action levels are recorded from the following criteria:

- Release criteria for M&E and structures (building surfaces) are based on USAEC *Regulatory Guide 1.86* ([USAEC 1974](#)).
- Release criteria for soils/sediment were derived from NUREG-1757, *Consolidated Decommissioning Guidance* [[NRC 2006a](#)]. NUREG-1757 values were based on not exceeding a dose limit from residual radioactivity of 25 mrem/y. For NAS JRB Willow Grove, the NUREG-1757 values were scaled down so that the dose from residual radioactivity would not exceed 15 mrem/y.

DCGLs (net of material background) shall serve as the action levels. Specific total radioactivity for each ROC is listed in [Worksheet #15](#). For soils and building sediment samples in which multiple radionuclides were used, the release criteria will be the sum of the fractions less than one.

### **Measurement Techniques**

Measurement techniques are described in detail in Section 7.0 of the management plan. The following types of measurements and samples may be utilized as inputs to the decision question.

- Large area gas proportional detector measurements
- Hand-held gas proportional detector measurements
- Scintillation detector measurements
- Geiger Mueller (GM) measurements in drain pipes
- Scintillation detector measurement of swipe samples
- Laboratory alpha, beta, and gamma spectroscopy of samples
- Liquid Scintillation Counting of swipe samples for tritium

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

Section 8.0 of the management plan describes the number and types of measurements included as part of the area surveys.

### **STEP 4: Define the Boundaries of the Study**

Areas or items of interest where data will be collected include building surfaces, sediment in sediment traps and drains and soil that could have been contaminated with radionuclides as a result of site-related operations. The initial boundaries for this survey include buildings and surface areas identified below and in the HRA ([Tetra Tech 2012](#)). The potentially affected media include surface soils, concrete and tile floors, exterior concrete and sheet metal walls, interior sheetrock, wood panel walls, acoustic tile ceilings and sediment on surfaces and in drains. Expansion of the boundaries may occur if contamination is identified at the periphery of an area in such a manner that it would be reasonable to assume the contamination could continue beyond the originally defined boundary (for example, within 6 feet of an established boundary, excluding walls). The specific boundaries for each of the buildings and surface areas are identified in the TSPs for that area. Sediment sampling would only be necessary if the buildings and locations have floor drains with sufficient sediment quantity to produce a representative sample. Spatial boundaries apply for these investigations:

***Building 4 (Footprint): (1,680 square meters [ $m^2$ ])***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 18 (Footprint): (266  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 20 (Footprint): (1,535  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 22: (1,579  $m^2$ )***

A scoping survey will be performed of the building interior as a single Class 3 survey unit.

***Building 23 (Footprint): (1,535  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 29: (1,839  $m^2$ )***

Scoping survey will be performed on the building interior as a single Class 3 survey unit.

***Building 77 (Footprint): (1,363  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 80 (4,188  $m^2$ )***

Scoping surveys will be performed as four Class 3 survey units in the Hangar proper, five Class 3 survey units in the North Lean To and two Class 3 survey units in the South Lean To.

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

***Building 118: (42 m<sup>2</sup>)***

A scoping survey will be performed of the building interior as two Class 3 survey units.

***Building 140 (376 m<sup>2</sup>)***

Scoping surveys will be performed as seven Class 3 survey units.

***Building 175: (30,035 m<sup>2</sup>)***

Scoping survey will be performed in four Class 3 survey units in the Hangar proper and two Class 3 survey units in the electronic maintenance shops.

***Building 177: (1,490 m<sup>2</sup>)***

Scoping survey will be performed in two Class 3 survey units in the Hangar proper and two Class 3 survey units in the support areas.

***Building 180: (865 m<sup>2</sup>)***

Scoping survey will be performed in four Class 3 survey units.

***Building 601 (870 m<sup>2</sup>)***

Scoping surveys will be performed as ten Class 3 survey units.

***Building 680 (2,787<sup>2</sup>)***

Scoping survey will be performed in three Class 3 survey units in the Hangar proper and three Class 3 survey units in the electronic maintenance shops.

***Site 1 (Landfill Footprint): (8,093 m<sup>2</sup>)***

Scoping survey will be performed of known or suspected disposal areas.

***Site 3 (Landfill Footprint): (32,421 m<sup>2</sup>)***

Scoping survey will be performed of known or suspected disposal areas.

***Site 12 (Landfill Footprint): (44,514 m<sup>2</sup>)***

Scoping survey will be performed of known or suspected disposal areas.

Note: A Class 3 Survey Unit is defined in MARSSIM [NRC 2000] as an area that has been impacted, has little or no potential for delivering a dose above the release criterion and has little or no potential for small areas of elevated activity. There is no limit on the total area of a Class 3 area.

### **STEP 5: Develop the Analytic Approach**

The objective of the management plan and SAP focuses on whether a specific building or land area at NAS JRB Willow Grove has residual radioactivity below levels that will allow for unrestricted/free release. HRA recommendations for a scoping survey must be surveyed as a

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

Class 3 or greater. Characterization survey recommendations must be surveyed as a Class 2 or greater. Areas known to have been previously contaminated must be surveyed as Class 1 areas.

The decision rules applicable to this project are:

- If any background subtracted scan measurement is greater than the DCGL, then take a fixed measurement to confirm the elevated reading, otherwise continue scanning. If an elevated reading is confirmed by a static reading to exceed the release criteria, then classify the unit as having failed the survey and designate it for further investigation.

If the level of background-corrected radioactivity in each sample collected from building surfaces or sediment samples is less than the applicable release criteria (See [Worksheet #15](#)) for a particular site, then recommend no further investigation and a unrestricted/free release of the location, otherwise document the survey/sample location, the extent and level of contamination and recommend that the survey/sample location be designated for possible future remediation.

Note: Background reference area measurements must be performed in non-impacted facilities constructed of similar materials, using similar measurement methods and constructed during the same timeframe as the impacted sites. These reference area measurements will consist of scanning and static surface measurements for comparison to the associated measurements to be performed at the impacted sites. Background reference areas will be identified by the SPM and PHP with the approval of RASO. Additional background reference areas may be required during survey operations if variances in background relative to survey areas are identified.

### **STEP 6: Specify Performance or Acceptance Criteria**

The surveys and sediment sampling will be performed from locations suspected to be, or most likely to be, contaminated by historical operations and from locations intended to bound the lateral extent of contamination. Determining the vertical extent of contamination is only applicable when sediment sampling would be necessary due to the presence of floor drains in buildings. The survey design is based on historical background information and is designed as a graded approach; the consequences of making a decision error are biased toward collecting additional information and taking corrective action to reduce or eliminate contamination levels. Any sampling uncertainty is controlled by the survey design which collects more data in areas with the greatest potential for residual radioactivity exceeding background. Surveying in locations most likely to have contamination is a part of the strategy because only one survey unit must exceed the applicable release criteria for the location not to be issued a free release of the entire location, making this a conservative investigate approach.

Analytical uncertainty is controlled by use of appropriate instruments, methods, techniques, and QC. Direct measurement MDCs for individual radionuclides using specific analytical methods are identified in Section 7.0 of the management plan. The MDC calculation assumes a Type I

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

decision error rate ( $\alpha$ , the probability of deciding a detector response is above background when only background radiation is present) and a Type II decision error rate ( $\beta$ , probability of deciding a detector response is background when radiation is present at levels above background) of 0.05. Specifying values for MDC helps control the level of uncertainty associated with individual analytical results, which helps control decision errors. A discussion of MDC calculations can be found in Section 7.2 of the management plan.

### **STEP 7: Develop the Plan for Obtaining Data**

Measurement locations and techniques have been selected to provide near real-time data during implementation of field activities. These data will be evaluated and used to refine the scope of field activities, as needed, to optimize implementation of the survey design and ensure the data quality objectives (DQO) are met. The completed survey measurement results from this SAP will be used to determine those areas that meet the release criteria defined in Section 6.0 of the management plan. Generic information regarding types of radiation measurements, instrument detection capabilities, selection of quantities and locations of data to be collected, is contained in this SAP and associated management plan. Site-specific operational details and theoretical assumptions will be identified in relevant TSPs. The proposed survey and sampling program is presented in [Worksheet #17](#) and summarized below.

#### Implementation Phase

The survey design is carried out in accordance with the TSPs resulting in the generation of raw data. All surveys will be performed to the level of Final Status Survey (FSS). Areas that exceed the release criteria presented in [Worksheet #15](#) and Table 6-1 of the management plan will be investigated, marked and documented in survey reports to support remediation efforts that would follow if necessary; however, remediation efforts would be outlined in a separate or revised TSP. Following remediation activities, the affected survey unit area will be resurveyed to demonstrate compliance with the release criteria. The types of surveys and the methods used to perform those surveys are presented in Section 4.0 of the management plan. Additionally, QA/QC measurements will generate data and other important information that will be used during the assessment phase for comparison purposes between reference background, radioactivity detections and normal daily checks of the equipment.

#### Assessment Phase

Assessment activities will be completed in accordance with [Worksheets #34](#) thru [#37](#).

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

### Decision-making Phase

A decision is made, in coordination with the stake holders, based on the conclusions drawn from the assessment process. The ultimate objective is to make technically defensible decisions with a specified level of confidence. When determining compliance with Scoping and FSS goals, the survey data are reviewed. Compliance tests are summarized as follows and outlined in the decision rules above:

- Compare the largest measurement with the DCGL (net of material background).
- Compare the average measurement with the DCGL (net of material background).
- If scan measurements are above the DCGL, then a fixed measurement will be taken to confirm the elevated reading. If the elevated reading is confirmed to exceed the release criteria, then the unit would fail.

When multiple nuclides are present, each with an individual DCGL, the most restrictive criteria will be applied unless the specific nuclides and ratios are identified. If the nuclides and ratios are known, the criteria will be assessed in accordance with the methods given in Section 6.0 of the management plan.

## **SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE**

(UFP-QAPP Manual Section 2.6.2)

The primary means of data collection for this project will be direct survey using surface contamination monitor (SCM) for structures and direct gamma scanning surveys for outdoor areas. Samples will be obtained for off-site analysis. Soil and sediment samples will be collected in areas required by the TSPs. All samples will be analyzed to determine isotope specific activities. Both biased and unbiased surface soil samples will be collected at the outdoor sites. The number of samples collected at each site will be specified in the TSP. Based on scanning and static measurements, tritium (H-3) swipes will be collected in Buildings 80 and 601. The number and location will be based on MARSSIM protocols described in Sections 4.4 and 5.3.3.1 of the management plan, and at any area exhibiting increased counts on the beta surface scan.

An undetermined number of sediment samples may be collected from floor drains at various sites. These samples will be analyzed off site for ROCs, but the results will only be used for characterization (isotope identification) and will not be subject to the QC and validation criteria established in this SAP. Likewise, an undetermined number of swipe samples will be collected on building surfaces and materials and analyzed on site for gross alpha and beta contamination. These samples are for characterization only and fall outside of the scope of the QC and validation criteria established in this SAP.

The following sections address QC measures for both field surveying and off-site laboratory analysis.

### **12.1 QUALITY CONTROL SAMPLES**

QC samples are collected and analyzed to check sampling and analytical precision, accuracy, and representativeness. Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD).

Field sampling precision is evaluated by analyzing field duplicate samples. Field duplicates will be collected and analyzed at a frequency of 10 percent for soil/sediment samples.

Laboratory analytical precision is evaluated by analyzing laboratory duplicates. The results of the analysis of each duplicate pair will be used to calculate an RPD for evaluating precision.

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the laboratory controls samples (LCS) or blank spikes, and method blanks. LCS or blank spikes are also analyzed at a frequency of 5 percent. The results of the spiked samples are used to calculate the percent recovery (%R) for evaluating accuracy.

## **SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)**

Table 12-1 presents accuracy goals for the investigation based on the percent recovery of matrix spikes. Results that fall outside the accuracy goals will be further evaluated based on the results of other QC samples.

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. Representative data will be obtained for this project through careful selection of sampling locations and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will also be ensured through the consistent application of established field and laboratory procedures. Laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be non-representative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability is exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

### **12.2 FIELD QUALITY CONTROL SAMPLES**

The following section discusses the types of field QC samples that will be collected for this project.

#### **12.2.1 Field Duplicates**

Field duplicate samples are collected at the same time and from the same source and then submitted as separate samples to the laboratory for analysis. For this project, field duplicates will only be collected for soil and sediment samples. Field duplicates for soil/sediment samples will be collected at a rate of 10 percent. Results from the analysis of soil/sediment field duplicates are used to evaluate precision by calculating the RPD.

### **12.3 LABORATORY QUALITY CONTROL SAMPLES**

The types of laboratory QC samples for this project are discussed in the following sections.

## **SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)**

### **12.3.1 Method Blanks**

Method blanks will be prepared at the frequency prescribed in the individual analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method.

### **12.3.2 Matrix Spike and Matrix Spike Duplicates**

Matrix spike/matrix spike duplicates (MS/MSD) are QC check samples that measure matrix-specific method performance for chemical analysis where analyte recovery is performed to evaluate laboratory accuracy. The results of the spiked samples are used to calculate the %R for evaluating accuracy.

### **12.3.3 Laboratory Control Samples**

LCS, or blank spikes, will be analyzed at the frequency prescribed in the analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method. If %R results for the LCS are outside of the established goals, laboratory-specific protocols will be followed to gauge the usability of the data.

### **12.3.4 Control of Field Measurements**

Control of field measurements obtained using static and scanning instrumentation is detailed in Section 7.0 of the management plan. Data quality is controlled in accordance with applicable SOPs. A list of applicable SOPs addressing data quality control is provided in [Worksheet #19](#). In addition, the SOPs are located in Attachment 4 of the management plan. Field equipment sensitivity performance criteria are provided in [Worksheet #22](#).

## SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)

**TABLE 12-1: MEASUREMENT PERFORMANCE CRITERIA TABLE – FIELD QC**

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Field Duplicate	Radionuclides (Gamma Spec), Alpha Spectroscopy, Sr-90, and tritium	One per 10 field samples	Precision	≤50% RPD	S&A

Notes:

A	Analytical
DQI	Data Quality Indicators
QC	Quality Control
RPD	Relative Percent Difference
S	Sampling
Sr-90	Strontium 90

**SAP WORKSHEET #13 – SECONDARY DATA CRITERIA AND LIMITATIONS  
TABLE**

(UFP-QAPP Manual Section 2.7)

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
<i>No secondary data used in developing this SAP.</i>				

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS**

(UFP-QAPP Manual Section 2.8.1)

### **14.1 PROJECT DESCRIPTION**

The primary objective of this project is to perform radiological surveys of building surfaces and conduct sampling and analysis of swipe and sediment samples to determine if specified buildings at NAS JRB Willow Grove can be released or if further actions may be necessary. The primary object for outdoor areas is to perform gamma walkover surveys and soil sampling to assess surficial risks from potential residual radioactivity and to assign land use controls if required. The following field activities will be performed:

- TSP preparation
- HASP preparation
- Mobilization/demobilization
- Site specific health and safety training
- Survey equipment QC checks
- Field survey activities (scanning and static measurements, removable contamination measurements)
- Demolition and disposal activities in support of field survey activities (removal of floor tile and mastic)
- Soil sampling
- Sediment sampling
- Waste management activities
- Field QA/QC management tasks
- Field documentation QA/QC and review tasks
- Off-site laboratory analysis of samples for ROCs
- Data validation
- Survey report generation

The majority of the data generated during field activities will be the result of radiological surveys performed on building surfaces and outdoor areas. These surveys will be in the form of scanning and static measurements for alpha and beta contamination for structures or scanning gamma

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS (CONTINUED)**

measurements for outdoor areas. As applicable, swipe samples for removable contamination will be collected and shipped for analysis at an off-site laboratory. The rationale for the survey design is discussed in general in SAP [Worksheet #17](#) and the management plan and in detail in the TSPs.

### **14.2 SURVEY METHODS**

Survey methods will be performed on building surfaces and outdoor areas in accordance with MARSSIM (NRC 2000) guidance. The TSPs identify the types, including both fixed and removable contamination, and extent of surveys that need to be performed, release criteria, survey unit classifications, decision logic for using real-time data to determine if additional/supplemental surveys are needed, and any other activities that might be required to complete the survey tasks. Data generated during field survey activities may be recorded on survey forms provide in SOP RP-OP-02, captured on a data logger, or recorded by laptop computer via a data link.

### **14.3 SOIL AND MEDIA SAMPLING**

Soil and media samples will be collected during field activities for analysis at an off-site laboratory and are identified in SAP [Worksheet #18](#). The number and type(s) of samples will be identified in the TSPs. Sampling will be performed in accordance with SOPs referenced in the worksheet. Additionally, other samples will be collected from various facilities to support evaluation of compliance with release criteria and to determine specific nuclides as necessary. These samples could include swipes or sediment, if found, in floor drains, sink drain openings, and ventilation openings or other concentration points if loose materials are found. All sample locations will be identified on a survey unit map.

### **14.4 ADDITIONAL FIELD ACTIVITIES**

In support of various field survey activities, remediation activities will be required to access potentially impacted surfaces. Loose equipment may consist of office materials such as desks and chairs, or other materials left from base operations. All materials will be surveyed for free release, using Regulatory Guide 1.86 release criteria (U.S. Atomic Energy Commission 1974). Because of the difficulty of performing adequate release surveys on floor tile, removed floor tile will be treated as low level radioactive waste (LLRW) and controlled and stored as such. Since the potential exists for the floor tiles or mastic to contain asbestos, it will also be controlled and labeled in accordance with applicable regulations (10 CFR 20 and 29 CFR 1910).

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS (CONTINUED)**

### **14.5 DATA MANAGEMENT**

This section provides direction for managing the environmental technical data associated with this SAP. Proper organization will ensure that data and documentation fully describe the results of the sampling and analysis activities performed in support of this SAP.

#### **14.5.1 Project Data Logbooks and Forms**

This project will generate project data logbooks and field forms (chain-of-custody [COC] data, maps, photographs, field audit reports) during sampling and data collection activities.

Project data will be recorded in project data logbooks or on approved forms. Multiple survey teams may use individual project data logbooks during the field effort. Sample collection forms, direct measurement forms, and photographic log sheets will be provided as needed to sampling teams in the field. All actions taken to review, approve, transfer, copy, duplicate, backup, store or secure project data will be noted in a project data logbook.

Project data logbooks, individual team member logbooks, field data forms, COC forms, and copies of all electronic data files will be filled out as the activities are performed and collected at completion of fieldwork.

The data will be entered and reviewed for accuracy and completeness by the SPM, RE, or SS. Following review, the SPM, RE, or SS will certify accuracy of information in the project data logbooks. Following completion of the project, the PM will review and verify the project data logbooks for defensibility and accuracy.

Project data will be recorded in a project data logbook or on approved forms. Individual survey teams or instruments may use field data logbooks during the field effort as long as they are assigned to individual survey teams or equipment.

Data logbooks and approved forms are considered legal records. Logbooks will be permanently bound and the pages will be numbered. Pages may not be removed from logbooks under any circumstances. Logbook entries will be legible, factual, detailed, and complete and will be signed and dated by the individuals making the entries. Completed forms will be legible, detailed, factual, and signed and dated by the individual completing the form. If a mistake is made in a log or on a form, placing a single line through the erroneous entry and initialing and dating the correction will denote the error. Under no circumstances will any previously entered information be completely obliterated. Use of whiteout in data logbooks or on forms is not permitted for any reason.

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS (CONTINUED)**

### **14.5.2 Photographic Records**

Photographs of sample collection and direct measurement activities taken during the field operations will be documented in a project logbook or using approved forms. Electronic photos will be saved as Joint Photographic Experts Group (JPEG) format files. Descriptions of photographs will include the room number; direction photographer is facing, and any measurement location information relevant to the photograph to correlate location. Photographs will only be taken with the approval of the PHP or the SPM.

### **14.5.3 Data Media**

The data media will be physical and electronic in the form of project data logs (physical) and diskette with hard-drive and CD-ROM backup as defined in [Section 14.5.4](#) below.

### **14.5.4 Data Backup and Security Policy**

Project electronic data will be downloaded from its collection device (for example laptop computers and data loggers) on a daily basis. At the conclusion of each day's survey activities, electronic data collected that day will be backed up to appropriate removable media (for example compact disk, zip disk, or equivalent) and the backup will be removed from the site. The backup will not be stored in the same building in which the original project electronic data are stored.

## SAP WORKSHEET #15 – REFERENCE LIMITS AND EVALUATION TABLE

(UFP-QAPP Manual Section 2.8.1)

Radionuclides	CAS Number	SURFACES	SOILS <sup>b</sup>	WATER <sup>d</sup>	Laboratory Specific	
		Structures, M&E, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	pCi/g <sup>c</sup>	pCi/L	QL pCi/g	MDA pCi/g
Radium-226	13982-63-3	100	1.0	5 <sup>e</sup>	0.7	0.33
Strontium-90	10098-97-2	1,000	1.02	8	0.32	0.32
Tritium (H-3)	10028-17-8	5,000	66	20,000	10 pCi/ sample	10 pCi/ sample
Uranium-238	7440-61-1	5,000	8.4	30	0.5	0.5

Notes:

pCi/g picocurie per gram

pCi/L picocuries per liter

dpm disintegration per minute

a These limits are based on AEC Regulatory Guide 1.86 ([USAEC 1974](#)). Values indicate the measured value above background as determined from the reference area. Limits for removable surface activity are 20 percent of these values.

b These limits are based on Nuclear Regulatory Commission document NUREG-1757, Consolidated Decommissioning Guidance ([NRC 2006](#)), whose limits are deemed in compliance with the 25 mrem/y unrestricted dose limit in 10CFR20.1402. Listed values were developed by scaling the NUREG-1757 values to 15 mrem/y unrestricted dose.

c Criteria is above background for those radionuclides found in background soils.

d Release criteria for water have been derived from *Radionuclides Notice of Data Availability Technical Support Document* ([EPA 2000](#)) Table III, which compared the federal drinking water standards from the 1976 and 1991 Maximum Contaminant Levels. This value reflects the most conservative limit.

e Limit is for total Radium Concentration.

**SAP WORKSHEET #16 – PROJECT SCHEDULE / TIMELINE TABLE**  
(UFP-QAPP Manual Section 2.8.2)

Activities	Organization	Deliverable	
		Anticipated Date of Completion	Version
Prepare and Submit Internal Draft Management plan	Tetra Tech	6/13/12	Internal Draft
Review Internal Draft Management plan	Navy	4/12/12	NA
Revise Internal Draft Management plan	Tetra Tech	10/10/12	Internal Draft
Prepare and Submit Revised Internal Draft Management plan	Tetra Tech	10/10/12	Revised Internal Draft
Review Revised Internal Draft Management plan	Navy	1/14/13	NA
Prepare RTC on Revised Internal Draft Management plan	Tetra Tech	1/31/13	NA
Review RTC on Revised Internal Draft Management plan	Navy	1/31/13	NA
Prepare and Submit Draft Management plan	Tetra Tech	6/14/13	Draft
Draft Management plan Review - Regulators	Agency	TBD	NA
Prepare RTC on Draft Management plan	Tetra Tech	TBD	NA
RTC on Draft Management plan Review- Regulators	Agency	TBD	NA
Prepare and Submit Draft Final Management plan	Tetra Tech	TBD	Draft Final
Draft Final Management plan Concurrence Period	Agency	TBD	NA
Prepare and Submit Final Management plan	Tetra Tech	TBD	Final
Conduct Radiological Surveys	Tetra Tech	TBD	NA

## **SAP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE** (UFP-QAPP Manual Section 3.1.1)

### **17.0 SAMPLING DESIGN AND RATIONALE**

This project involves a radiological survey to support disposition decisions for buildings, outdoor areas and equipment at NAS JRB Willow Grove. These include interior portions of standing buildings and sediment, demolished building footprints and IR Sites. These buildings and outdoor areas have been identified as impacted areas in the HRA, NAS JRB Willow Grove, History of the Use of General Radioactive Materials, 1943-2011 ([Tetra Tech 2012](#)). Activities at these buildings and outdoor areas involving radioactive materials included handling of radioluminescent items (such as aircraft instrument panels), maintenance and storage of DU counterweights, storage and maintenance of aircraft parts with radioactive materials (such as drogue lights) storage and maintenance of weapons, the storage of non-licensed commodity items (such as tritium (H-3) exit signs) and the disposal of potentially radioactive commodities at operating landfills. The management plan and associated TSPs are intended to provide technically sound data and information to determine the status of the facilities relative to an unrestricted release.

The HRA ([Tetra Tech 2012](#)) provides the details regarding where and when radioactive materials were used in each of the buildings. A summary of each of the involved buildings and the means by which they may have been impacted by operations with radioactive materials is included in the TSPs, in conjunction with this management plan. The HRA ([Tetra Tech 2012](#)) defines specific areas within buildings that are impacted and the associated ROCs. The HRA ([Tetra Tech 2012](#)) provides initial classifications in accordance with the MARSSIM ([NRC 2000](#)).

Release criteria for the basewide radiological survey management plan are based on U.S. Atomic Energy Commission (USAEC) Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* ([USAEC 1974](#)), or a concentration that is equivalent to 15 millirem per year (mrem/y) from residual radioactivity. These values were obtained by scaling the values found in Nuclear Regulatory Commission document NUREG-1757, Consolidated Decommissioning Guidance ([NRC 2006](#)), which are based on a 25 mrem/y dose, to 15 mrem/y. The release criteria for materials and equipment are also based on Regulatory Guide 1.86 ([USAEC 1974](#)). Limits for removable surface activity on materials and equipment are 20 percent of the Regulatory Guide 1.86 surface activity limits.

### **17.1 SURVEY REQUIREMENTS**

The survey design requirements for each area classification are presented in the management plan and TSP. Requirements for scan speed, number distribution and count time for direct measurements, and removable contamination surveys are defined. Survey requirements for both alpha emitting and beta emitting radionuclides and for gamma scanning surveys are presented in the management plan and TSP. In some areas, equipment such as tile flooring and mastic are identified for removal to expose those surfaces that have the potential for residual contamination. Survey requirements for the materials and equipment to be removed are presented in the

## **SAP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE (CONTINUED)**

management plan and TSP. An area-by-area listing of the survey requirements is presented in the management plan and TSP.

For each building and outdoor area, the specific survey requirements are detailed in a TSP. The TSPs provide detailed instruction on an area by area basis to the field personnel to ensure that all aspects of the plan are implemented. Collection and management of data generated by the management plan and TSP is detailed to ensure data integrity, that valid analysis can be performed and that data are retrievable at future dates.

### **17.2 SAMPLING METHODS**

Samples will be collected during field activities to support the release of potentially impacted sites and to provide characterization data on facility systems (for example, floor drains and ventilation systems). Media sampling will also be used to characterize materials for waste disposal (for example, asbestos floor tile and mastic). All sampling activities will be conducted in accordance with SOPs.

Surface soil sampling will be performed as required by the TSPs. Samples collected from the potentially impacted area will be analyzed for the ROCs by an off-site laboratory.

Sediment sampling will be performed as required by the TSPs. Samples collected from the potentially impacted area will be analyzed for the ROCs by an off-site laboratory.

Swipe samples will be collected in areas where tritium is listed as an ROC using standard tritium sampling techniques. These samples will be analyzed for tritium by an off-site laboratory. The total number of tritium swipes will be determined based on field screening results.

Additionally, an undetermined number of swipe and sediment samples will be collected for characterization purposes only. These samples could include swipes of material, floor/sink drain openings, ventilation openings, and sediment samples from floor drains. All sample locations will be identified on a survey map. The swipe samples will be analyzed on site for gross alpha and beta activity using a scintillation detector identified in Table 7-1 of the management plan, and the surface soil and sediment samples will be sent to an off-site laboratory for analysis. It is doubtful that adequate sediment sample volume will be recovered from floor drains to allow for a full suite of analyses to be performed, so the priority will be for gamma spectroscopic analysis. The results of the swipe and sediment samples will be qualitative in nature and will be used only for characterization purposes.

## **SAP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE (CONTINUED)**

### **17.3 MANAGEMENT OF INVESTIGATION-DERIVED WASTE**

Investigation-derived waste (IDW) may be generated during field activities. If generated, this material will be stored in 55-gallon drums, B-12 or B-25 boxes, roll-off containers, or intermodal containers. This material will be sampled to characterize for disposal. The samples will be analyzed for ROCs by an off-site laboratory. The results of this analysis will be provided to the radiological waste contractor under the direction of the Navy Low Level Radioactive Waste (LLRW) Disposal Program. These samples will be analyzed for characterization only, and sample results will not be subject to the QC and validation criteria established in this SAP.

### **17.4 MANAGEMENT OF RADIOLOGICAL WASTE**

Radiologically contaminated debris may be generated during remediation activities. This material could consist of floor tiles and mastic and miscellaneous debris.. If unconditional release surveys determine that these items are contaminated above release limits or if a release survey is not possible, then the items will be containerized as described in paragraph 17.3 above. The radiological waste contractor will further characterize the waste and assure appropriate disposal under the direction of the Navy LLRW Disposal Program.

**SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP  
REQUIREMENTS TABLE**  
(UFP-QAPP Manual Section 3.1.1)

**TABLE 18-1: SAMPLING LOCATIONS AND METHOD/SOP REQUIREMENT TABLE**

Sampling Location/ ID Number <sup>1</sup>	Matrix	Depth (ft.)	Analytical Group	Number of Samples <sup>2</sup>	Sampling SOP Reference
Building 80/080-SWI-001 to 187	Swipes (H-3)	Surface	Tritium	187	SOP 009
Building 80/D	Swipes (H-3)	Surface	Tritium	19 duplicates	SOP 009
Building 601/601-SWI-001 to 170	Swipes (H-3)	Surface	Tritium	170	SOP 009
Building 601/D	Swipes (H-3)	Surface	Tritium	17 duplicates	SOP 009
Building 4/004-SOI-TBD	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 4/D	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 18/018-SOI-TBD	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 18/D	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 20/020-SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 20/D	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 22/022-SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 22/D	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 23/023-SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 23/D	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 29/029-SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 29/D	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 77/077-SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 77/D	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 80/080-SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
Building 80/D	Sediment	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009

## SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Sampling Location/ ID Number <sup>1</sup>	Matrix	Depth (ft.)	Analytical Group	Number of Samples <sup>2</sup>	Sampling SOP Reference
Building 118/118- SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 118/D	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 140/140- SED-TBD	Sediment	0 – 0.5	Ra-226	TBD	SOP 009
Building 140/D	Sediment	0 – 0.5	Ra-226	TBD	SOP 009
Building 175/175- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 175/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 177/177- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 177/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 180/180- SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90, U- 238	TBD	SOP 009
Building 180/D	Sediment	0 – 0.5	Ra-226, Sr-90, U- 238	TBD	SOP 009
Building 601/601- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 601/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 680/680- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 680/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
IR Site 1/IR1-SOI- TBD	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 1/D	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 3/IR3-SOI- TBD	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 3/D	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009

## SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Sampling Location/ ID Number <sup>1</sup>	Matrix	Depth (ft.)	Analytical Group	Number of Samples	Sampling SOP Reference
IR Site 12/IR12- SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 12/D	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009

Notes:

- 1 Sediment samples from drains in the various buildings will be collected, if available, as described in the management plan and TSP. Swipe samples will be collected as directed by the TSP. All sample locations will be logged and mapped.
- 2 The number of surface soil samples collected at the outdoor sites will be specified in the TSP.

D	Duplicate
H-3	Tritium
ID	Identification
N/A	Not applicable
Ra-226	Radium 226
SOP	Standard operating procedure
Sr-90	Strontium 90
TBD	To be determined
U-238	Uranium 238

### Sample Numbering

Field samples will be numbered using a numbering system listing the building (or location), the sample type, and a sequential numbering system (for example 200-SED-0001). The first position indicates the building or location. The following table matches the identifier with the correct building or location.

004 = Building 4	140 = Building 140
018 = Building 18	175 = Building 175
020 = Building 20	177 = Building 177
022 = Building 22	180 = Building 180
023 = Building 23	601 = Building 601
029 = Building 29	680 = Building 680
077 = Building 77	IR1 = IR Site 1
080 = Building 80	IR3 = IR Site 1
118 = Building 118	IR12 = IR Site 12

The second position corresponds to the sample type; where “SOI” is a soil sample, “SED” is a sediment sample, “COR” is a core sample, and “SWI” is a swipe sample. The identifier “001” corresponds to a sequential number. All samples will be logged in the sample logbook.

## **SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)**

**TABLE 18-2: SURFACE CONTAMINATION MONITOR OPERATIONS PROCEDURES (ATTACHMENT 4)**

<b>Procedure</b>	<b>Title</b>	<b>Rev</b>
SCM-OPS-01	Position Sensitive Proportional Counters Purging	0
SCM-OPS-02	Position Sensitive Proportional Counters Plateau Determination	0
SCM-OPS-03	Position Sensitive Proportional Counters Position Calibration	1
SCM-OPS-04	Encoder Calibration	0
SCM-OPS-05	Position Sensitive Proportional Counters Efficiency Calibration	0
SCM-OPS-06	Position Sensitive Proportional Counters Quality Assurance	1
SCM-SETUP-01	Position Sensitive Proportional Counters Repair	0
SCM-SETUP-02	Hardware Setup	0
SCM-SETUP-03	Quality Assurance Testing of Surface Contamination Monitor	0

## SAP WORKSHEET #19 – ANALYTICAL SOP REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

**TABLE 19-1: ANALYTICAL SOP REQUIREMENTS TABLE**

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference	Containers (number, size, and type)	Sample volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Soil/Sediment/Solids	Radionuclides <sup>1</sup> (Gamma Spectroscopy)	EPA Method 901.1 or equivalent / GL-RAD-A-013 R25	500-mL plastic container	At least 500 grams	Not applicable	N/A
Soil/Sediment/Solids	Radionuclides (Isotopic Uranium)	A-01-R MOD / GL-RAD-A-011 R23	500-mL plastic container	At least 500 grams	Not applicable	N/A
Soil/Sediment/Solids	Radionuclides (Sr-90)	EPA Method 905 MOD / GL-RAD-A-004 R16	500-mL plastic container	At least 500 grams	Not applicable	N/A
Swipes	Tritium (H-3)	EPA Method 906.0 MOD / GL-RAD-A-002 R21	250 mL glass vial with screw-on cap	1 swipe per vial	Not applicable	6 months

<sup>1</sup> The laboratory will report the "long list" gamma emitting isotopes

EPA U.S. Environmental Protection Agency  
H-3 Tritium  
mL Milliliter

N/A Not Applicable  
SOP Standard Operating Procedure  
Sr-90 Strontium 90

**TABLE 19-2: TESTAMERICA LABORATORY PROCEDURES**

Procedure	Title	Rev
GL-RAD-I-001	Gamma Spectroscopy	19
GL-RAD-I-009	Alpha Spectroscopy	14
GL-RAD-I-004, GL-RAD-I-014 & GL-RAD-I-017	Liquid Scintillation	17 14 11
GL-RAD-I-006 & GL-RAD-I-016	Low Background Gas Flow Proportional Counting (GFPC) System	14 7

**SAP WORKSHEET #20 – FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE**  
(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	No. of Sampling Locations <sup>1</sup>	No. of Field Duplicates	Total No. of Samples to Lab
Swipes	Tritium	357	36	393
Surface Soils	Gamma Spec, Alpha Spec, GFPC	TBD	TBD	TBD

Alpha Spec	Alpha Spectroscopy
Gamma Spec	Gamma Spectroscopy
GFPC	Gas Flow Proportional Counting
H-3	Tritium
TBD	To be determined

**SAP WORKSHEET #21 – PROJECT SAMPLING SOP REFERENCES TABLE**  
(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 006	Radiation and Contamination Surveys, Rev. 0	Tetra Tech	GM, Gas Flow proportional and/or Scintillation Detectors. Cloth and Massilin-type swipes	No	None
SOP 008	Air Sampling and Sample Analysis, Rev.0	Tetra Tech	Low-volume, high-volume and lapel air samplers	No	None
SOP 009	Sampling Procedures for Radiological Surveys, Rev. 0	Tetra Tech	Hand Auger, Split Spoon Sampler or Equivalent. Trowel or equivalent flat surface instrument	No	None

Notes:

GM                      Geiger-Mueller

**SAP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE,  
TESTING, AND INSPECTION TABLE**  
(UFP-QAPP Manual Section 3.1.2.4)

Calibration and quality control procedures for field instrumentation will be performed to ensure instruments are operating properly and produce data that satisfy the project objectives. Routine calibration and standardization will be performed prior to use and verified during use to ensure that instruments are operating properly and are producing accurate and reliable data. Instruments will be calibrated by an approved vendor in accordance with American National Standards Institute (ANSI) N323, American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments (ANSI 1997), at a frequency recommended by the manufacturer. At a minimum, calibrations of radiation detection instruments will be performed annually and after repair. Field instrument checks, using National Institute of Standards and Technology (NIST) traceable sources, will verify instrument response, and will typically be performed at the beginning and end of each day, at a minimum. If the instrument checks reveal that the instrument is outside established accuracy limits, the instrument will be marked out of service. If necessary, the instrument will be returned to the manufacturer for immediate repair and servicing.

Control of field measurements obtained using static and scanning instrumentation is detailed in Section 7.0 of the management plan. Data quality is controlled in accordance with applicable SOPs.

## SAP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE (CONTINUED)

Measurement/ Technique	Type of Instrument		Calibration Frequency <sup>1</sup>	Response Check <sup>2</sup>	Acceptance Criteria <sup>3</sup>	Corrective Action
	Detector	Meter Description				
Surface Alpha Scan	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Surface Alpha Scan	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Surface Beta Scan	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Surface Beta Scan	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Static Alpha Measurement	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Static Alpha Measurement	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 Hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Static Beta Measurement	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Static Beta Measurement	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 Hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Static Beta Measurement	Geiger-Mueller Model 44-9	Ratemeter 3	Annual	Daily	$\pm$ 20%	Remove from service
Swipe Analyzer	Ludlum 43-10-1 Scintillation Probe	Ludlum Model 2929	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Gamma Scans	Ludlum 44-10	Ludlum Model 2241 or 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service

**SAP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE  
(CONTINUED)**

Measurement/ Technique	Type of Instrument		Calibration Frequency <sup>1</sup>	Response Check <sup>2</sup>	Acceptance Criteria <sup>3</sup>	Corrective Action
	Detector	Meter Description				
Gamma Exposure Rate	Micro R meter Ludlum Model 19	Sodium Iodide	Annual	Daily	± 20%	Remove from service

<sup>1</sup> Gas Proportional Counters and Scintillation Counters will have the efficiency of each instrument established using a NIST traceable source prior to use in this project and annually or following instrument repair that affects the performance characteristics.

<sup>2</sup> Response checks are not required for instruments not in use.

<sup>3</sup> The listed acceptance criterion for the PSPC is for performance based checks. A daily source check is also performed with an acceptance criterion of ± 20%.

## SAP WORKSHEET #23 – ANALYTICAL SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.2.1)

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
GL-RAD-A-013	Gamma Spec Analysis, R25	Definitive	Soil & Sediment / Gamma	HPGe	GEL Laboratories, LLC Charleston, SC	No
GL-RAD-A-004	Sr-90 Analysis, R16	Definitive	Soil & Sediment / Sr-90	GFPC	GEL Laboratories, LLC Charleston, SC	No
GL-RAD-A-011	Alpha Spectroscopy Analysis, R23	Definitive	Soil & Sediment / Iso-U	Alpha Spectrometer	GEL Laboratories, LLC Charleston, SC	No
GL-RAD-A-011	Liquid Scintillation Counter Analysis, R21	Definitive	Swipes / H-3	Liquid Scintillation Counter	GEL Laboratories, LLC Charleston, SC	No

### Notes:

GFPC      Gas Flow Proportional Counter  
 H-3      Tritium  
 HPGe      High Purity Germanium  
 Iso-U      Isotopic Uranium  
 SOP      Standard Operating Procedure  
 Sr-90      Strontium 90

## SAP WORKSHEET #24 – ANALYTICAL INSTRUMENT CALIBRATION TABLE

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA <sup>1</sup>	SOP Reference <sup>2</sup>
Alpha Spectroscopy	ICAL	Monthly	Energy: each isotope $\pm 40$ keV of expected Energy: Slope $\leq 15$ keV/channel Efficiency: Fixed Point	Repeat initial calibration	Laboratory Analyst	GL-RAD-I-009
	CCV	Daily Pulser	Within "Boundary" parameters	Repeat CCV once; repeat ICAL if second CCV fails	Laboratory Analyst	GL-RAD-I-009
HPGe Gamma Spectroscopy System	ICAL	Yearly	Energy within 0.1keV FWHM $\leq 3.0$ keV at 1332 keV Efficiency $\leq 8\%$	Repeat initial calibration	Laboratory Analyst	GL-RAD-I-001
	ICV	After ICAL	Efficiency $\leq 10\%$	Repeat ICV once; repeat ICAL if second ICV fails	Laboratory Analyst	GL-RAD-I-001
	CCV	Daily	Control chart mean $\pm 3 \sigma$	Repeat CCAL once; flag detector out of service for day if second CCAL fails	Laboratory Analyst	GL-RAD-I-001

## SAP WORKSHEET #24 – ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA <sup>1</sup>	SOP Reference <sup>2</sup>
Low Background Gas Flow Proportional Counting (GFPC) System	ICAL	Yearly	Individual Points $\pm 10\%$	Evaluation for possible repeat initial calibration	Laboratory Analyst	GL-RAD-I-006, GL-RAD-I-016
	ICV	After ICAL	Recovery $\pm 25\%$	Repeat ICV once; repeat ICAL if second ICV fails	Laboratory Analyst	GL-RAD-I-006, GL-RAD-I-016
	CCV	Daily	Control chart mean $\pm 3\sigma$	Repeat CCAL once; flag detector out of service for day if second CCAL fails	Laboratory Analyst	GL-RAD-I-006, GL-RAD-I-016
Liquid Scintillation Counting	ICAL	Yearly	Quench curve, 1000 counts per data point	Recalibration	Laboratory Analyst	GL-RAD-I-004, GL-RAD-I-014, GL-RAD-I-017
	ICV	After ICAL	Second Source check standard at quench curve - all $\pm 10\%$ of known value	Re-prep / reanalysis of ICV and/or ICAL	Laboratory Analyst	GL-RAD-I-004, GL-RAD-I-014, GL-RAD-I-017

Notes:

- 1 Name or title of responsible person may be used
- 2 Specify the appropriate reference letter or number from the Analytical SOP References table ([Worksheet #23](#)).

CA Corrective action  
 CCAL Continuing calibration  
 CCV Continuous calibration verification  
 FWHM Full width at half maximum  
 ICAL Initial calibration

ICV Initial calibration verification  
 keV Kilo electron volt  
 $\sigma$  Sigma  
 % Percent

**SAP WORKSHEET #25 – ANALYTICAL INSTRUMENT AND EQUIPMENT  
MAINTENANCE, TESTING, AND INSPECTION TABLE**  
(UFP-QAPP Manual Section 3.2.3)

Analytical instrument and equipment maintenance, testing and inspection is performed in accordance with the GEL Quality Assurance Plan, GL-QS-B-001 R26. Maintenance, testing and inspections requirements are contained in the laboratory SOPs listed in [Worksheet # 23](#).

**SAP WORKSHEET #26 – SAMPLE HANDLING SYSTEM**  
(UFP-QAPP Manual Appendix A)

<b>SAMPLE COLLECTION, PACKAGING, AND SHIPMENT</b>
Sample Collection (Personnel/Organization): Survey Technician/MSI
Sample Packaging (Personnel/Organization): Survey Technician/ MSI
Coordination of Shipment (Personnel/Organization): Site Supervisor/MSI
Type of Shipment/Carrier: Exempted Quantity/Federal Express
<b>SAMPLE RECEIPT AND ANALYSIS</b>
Sample Receipt (Personnel/Organization): Lab Technician/GEL
Sample Custody and Storage (Personnel/Organization): Lab Technician/ GEL
Sample Preparation (Personnel/Organization): Lab Technician/ GEL
Sample Determinative Analysis (Personnel/Organization): Lab Technician/ GEL
<b>SAMPLE ARCHIVING</b>
Field Sample Storage (No. of days from sample collection): See <a href="#">Worksheet #19</a>
Sample Extract/Digestate Storage (No. of days from extraction/digestion): See <a href="#">Worksheet #19</a>
Biological Sample Storage (No. of days from sample collection): Not applicable
<b>SAMPLE DISPOSAL</b>
Personnel/Organization: GEL

Notes:

MSI      Millennium Services, Inc.

## **SAP WORKSHEET #27 – SAMPLE CUSTODY REQUIREMENTS TABLE** (UFP-QAPP Manual Section 3.3.3)

### **27.1 SAMPLE IDENTIFICATION**

Unique sample identification numbers for field and field QA/QC samples will be assigned by the RE or SS as sample locations are identified in accordance with the numbering convention described in [Worksheet #18](#).

### **27.2 SAMPLE COLLECTION DOCUMENTATION**

Documentation of field observations will be recorded in project data logbooks and field forms, including sample collection forms, direct measurement forms, survey records and photographic log sheets. Field logbooks utilized on this project will consist of a bound, page numbered logbook. All pages of the logbooks will be numbered sequentially and observations will be recorded with indelible ink.

Field sample collection forms will be used to document sample collection details, and other observations and activities will be recorded in the project data logbook.

For sampling and field activities, the following types of information will be recorded in the project data logbooks or forms as appropriate:

- Site name and location
- Date and time of sample activities
- Personnel and their affiliations
- Weather conditions (if applicable)
- Activities involved with the sampling
- Subcontractor activity summary
- Site observations including site entry and exit times
- Site sketches made on site
- Visitor names, affiliations, arrival and departure times
- Health and safety issues including personal protective equipment (PPE)

## **SAP WORKSHEET #27 – SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)**

### **27.3 SAMPLE HANDLING AND TRACKING SYSTEM**

These subsections outline the procedures that will be used by field and laboratory personnel to document project activities and sample collection procedures during field survey activities. All forms must be filled in as completely as possible.

#### **27.3.1 Sample Handling**

Sample handling is described in [Worksheet #26](#). Samples will be collected and processed in accordance with applicable radiological SOPs.

#### **27.3.2 Sample Delivery**

Samples to be delivered to the laboratory will be made by FedEx. After samples have been collected, they will typically be sent to the laboratory within 24 hours.

#### **27.3.3 Sample Custody**

To ensure the integrity of a sample from collection through analysis, it is necessary to have an accurate, written record that traces the possession and handling of the sample. This documentation is referred to as the COC form. The chain of custody begins at the time of sample collection.

A sample is under custody if:

- The sample is in the physical possession of an authorized person
- The sample is in view of an authorized person after being in his/her possession
- The sample is placed in a secure area by an authorized person after being in his/her possession
- The sample is in a secure area, restricted to authorized personnel only

Custody documentation is designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. A multi-part form is used with each page of the form signed and dated by the recipient of a sample or portion of sample. The person releasing the sample and the person receiving the sample each will retain a copy of the form each time a sample transfer occurs.

## **SAP WORKSHEET #27 – SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)**

Integrity of the samples collected during the site investigation will be the responsibility of identified persons from the time the samples are collected until the samples, or their derived data, are incorporated into the final report.

The SS is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the COC form. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (FedEx Corporation). Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs identified in [Worksheet #23](#).

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE

(UFP-QAPP Manual Section 3.4)

<b>Matrix</b>	Soil
<b>Analytical Group</b>	Radionuclides (Gamma spec)
<b>Analytical Method / SOP Reference</b>	EPA Method 901.1 / GL-RAD-A-013 R25

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less.	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less.

Notes:

MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE (CONTINUED)

<b>Matrix</b>	Soil					
<b>Analytical Group</b>	Radionuclides (Isotopic Uranium)					
<b>Analytical Method / SOP Reference</b>	A-01-R-Mod MOD (modified for soil)/ GL-RAD-A-011 R23					
<b>QC Sample</b>	<b>Frequency / Number</b>	<b>Method / SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>Data Quality Indicator (DQI)</b>	<b>Measurement Performance Criteria</b>
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limits 20% or less.	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less.

Notes:

MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE (CONTINUED)

<b>Matrix</b>	Soil					
<b>Analytical Group</b>	Radionuclides (Sr-90/Total Sr) <sup>a</sup>					
<b>Analytical Method / SOP Reference</b>	EPA Method 905 MOD / GL-RAD-A-004 R16					
<b>QC Sample</b>	<b>Frequency / Number</b>	<b>Method / SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>Data Quality Indicator (DQI)</b>	<b>Measurement Performance Criteria</b>
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limits 20% or less	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less

<sup>a</sup> Samples will be analyzed for total Sr. If the total Sr value exceeds the release criteria (Worksheet 15), the sample will be analyzed for Sr-90.

Notes:

MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference  
 Sr Strontium  
 Sr-90 Strontium 90

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE (CONTINUED)

<b>Matrix</b>	Soil					
<b>Analytical Group</b>	Tritium (H-3)					
<b>Analytical Method / SOP Reference</b>	EPA Method 906.0 MOD / GL-RAD-A-002 R 21					
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less

Notes:

H-3 Tritium  
 MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference

## SAP WORKSHEET #29 – PROJECT DOCUMENTS AND RECORDS TABLE

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
<b><u>Sample Collection Documents and Records</u></b> Field logbook (and sampling notes) Field sample forms (boring logs, sample log sheets, drilling logs) Chain of custody records Sample shipment air bills Equipment calibration logs Photographs Sampling and Analysis Plan Field Sampling SOPs	Millennium Project file (Original records will be maintained by SS on site with back-up copies stored at an off-site location)
<b><u>Laboratory Documents and Records</u></b> Sample receipt/login form Sample storage records Sample preparation logs Standard traceability logs Equipment Calibration logs Sample analysis run logs Equipment maintenance, testing , and inspection logs Corrective action forms Reported field sample results Reported results for standards, quality control checks, and quality control samples Data completeness checklists Sample storage and disposal records Telephone logs Extraction/clean-up records Raw data	GEL Project file (Project file copy will subsequently be sent to NAVFAC MIDLANT Administrative Record)
<b><u>Data Assessment Documents and Records</u></b> Field Sampling Audit Checklist (if an audit is conducted) Analytical Audit Checklist (if an audit is conducted)	Tetra Tech Project file (Original records will be maintained by PM on site with back-up copies stored at an off-site location)
Data Validation Report	Tetra Tech Project file (Project file copy will subsequently be sent to NAVFAC MIDLANT Administrative Record)

Project-Specific SAP  
Naval Air Station Joint Reserve Base Willow Grove  
Willow Grove, Pennsylvania

Title: Basewide Radiological Surveys  
Revision Number: NA  
Revision Date: NA

## **SAP WORKSHEET #29 – PROJECT DOCUMENTS AND RECORDS TABLE (CONTINUED)**

Notes:

NAVFAC MIDLANT Naval Facilities Engineering Command Mid-Atlantic  
PM Project Manager  
SOP Standard Operating Procedure  
SS Shift Supervisor

## SAP WORKSHEET #30 – ANALYTICAL SERVICES TABLE

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization
Soil Sediment Solids	Gamma emitting isotopes	All	EPA Method 901.1	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566
Soil Sediment Solids	Total Sr	All	EPA Method 905	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566
Soil Sediment Solids	Alpha emitting isotopes	All	A-01-R	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566
Swipes	H-3	All	EPA Method 906	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566

Notes:

Labs are Pennsylvania certified and Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) approved.

EPA U.S. Environmental Protection Agency  
 H-3 Tritium

ID Identification  
 Sr Strontium

## **SAP WORKSHEET #30 – ANALYTICAL SERVICES TABLE (CONTINUED)**

### **30.1           LABORATORY QUALIFICATION**

Laboratories that support the Navy directly or through subcontracts are evaluated and approved for Navy use by the Naval Facilities Engineering Service Center (NFESC). Laboratories that support Tetra Tech under Navy contracts have been selected from the list of laboratories approved by NFESC and evaluated by Tetra Tech to assure that the laboratory can meet the technical requirements of the laboratory SOW and produce data of acceptable quality.

### **30.2           DATA DELIVERABLES**

The subcontracted laboratory will provide electronic data deliverable (EDD) for all analytical results generated for the field samples collected for off-site analysis. An automated laboratory information management system must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. EDDs will be compatible with the Navy electronic data deliverable (NEDD) format. Results that should be included in all EDDs are as follows:

- Target analyte results for each sample and associated analytical methods requested on the chain-of-custody form
- Method and instrument blanks and preparation and calibration blank results reported for the sample delivery group (SDG)
- Percent recoveries for the spike compounds in the MS, MSDs, blank spikes, or LCSs
- Matrix duplicate results reported for the SDG
- All re-analysis, re-extractions, or dilutions reported for the SDG, including any associated with samples and the specified laboratory QC samples

Electronic data must be retained for a minimum of 10 years after final data have been submitted. The subcontractor laboratory will use an electronic storage device capable of recording data for long-term, off-line storage. Raw data will be retained on an electronic data archival system.

Data will be reported in tabular format to be included in the report. The electronic data in NEDD format will be submitted to the Naval Installation Restoration Information Solution (NIRIS) database within 30 days of completion of validation, as described in EWI EVR.6, Environmental Data Management and Required Electronic Delivery Standards ([NFESCSW 2005](#)).

**SAP WORKSHEET #31 – PLANNED PROJECT ASSESSMENTS TABLE**  
(UFP-QAPP Manual Section 4.1.1)

<b>Assessment Type</b>	<b>Frequency</b>	<b>Internal or External</b>	<b>Organization Performing Assessment</b>	<b>Person(s) Responsible for Performing Assessment</b> (title and organizational affiliation)	<b>Person(s) Responsible for Responding to Assessment Findings</b> (title and organizational affiliation)	<b>Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)</b> (title and organizational affiliation)	<b>Person(s) Responsible for Monitoring Effectiveness of CA</b> (title and organizational affiliation)
Laboratory Systems Audit	Every 18 months to 2 years	External	DoD ELAP	Laboratory QA	Laboratory QA	Laboratory QA	Laboratory QA

Notes:

DoD            Department of Defense  
ELAP        Environmental Laboratory Accreditation Program  
QA            Quality Assurance

**SAP WORKSHEET #32 – ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES**  
(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Laboratory systems audit	Written audit report	TBD/Laboratory Lab QA, NFESC	Not specified by NFESC	Letter	Laboratory PM/QA, NFESC	Specified by NFESC

Notes:

NFESC	Naval Facilities Engineering Service Center
PM	Project Manager
QA	Quality Assurance
TBD	To Be Determined

## SAP WORKSHEET #33 – QA MANAGEMENT REPORTS TABLE

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data validation report	Weekly	Beginning of business, following week	SPM	Navy RPM, RASO
Major analysis problem identification (Internal Memorandum)	When persistent analysis problems are detected	Immediately	SPM or designee	Navy RPM, RASO
Project monthly progress report	Monthly for duration of the project	Monthly	SPM	Navy RPM, RASO
Field status reports	Weekly, oral, during the course of sampling	Weekly during field activities	SS	Navy RPM, RASO
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately	Lab QA	Navy RPM, RASO, PHP

Notes:

PHP Project Health Physicist  
 QA Quality Assurance  
 RASO Radiological Affairs Support Office  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager  
 SS Site Supervisor

**SAP WORKSHEET #34 – VERIFICATION (STEP I) PROCESS TABLE**  
(UFP-QAPP Manual Section 5.2.1)

Verification Input	Description	Internal (I) / External (E)	Responsible for Verification (name, organization)
Field Logbook	Field logbooks will be reviewed weekly and verified that the information is complete in accordance with requirements in <a href="#">Section 14.5</a> of this SAP.	I	SPM or designee, Millennium
COC Forms	COC forms will be reviewed against shipping container contents. The COC will be signed and the original will be shipped to the laboratory within the cooler. The copy will be kept in project files.	I	SPM or designee, Millennium
Sample acknowledgement	The sample acknowledgment generated by the laboratory will be reviewed against the COC for accuracy and for potential analytical issues.	E	Laboratory custodian, TBD
Laboratory Data Package	Prior to submittal to Tetra Tech, the laboratory will review the laboratory data and associated pages for completeness and technical readiness.	E	Laboratory technician, TBD
Laboratory data package/electronic data	The laboratory data and electronic data will be reviewed by Tetra Tech to confirm all sample analyses requested have been provided and that all of the required information for validation has been included in the data package. Tetra Tech will also compare the electronic data to the hard copy report for consistency.	I	SPM PHP/ Tetra Tech
Field and Electronic Data	One hundred percent of manual entries will be reviewed against the hard-copy information. 100 percent of the output from data processing will be validated in accordance with SOP and TSP requirements.	I	SPM or designee, Millennium

Notes:

COC Chain of Custody  
PHP Project Health Physicist  
SAP Sampling and Analysis Plan

SOP Standard Operating Procedure  
SPM Subcontract Project Manager  
TSP Task Specific Plan

## SAP WORKSHEET #35 – VALIDATION (STEPS IIA AND IIB) PROCESS TABLE

(UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)(Worksheet #37)

Step Ila / Iib <sup>1</sup>	Validation Input	Description	Responsible for Validation (name, organization)
Ila	SOPs, SAP	Examine field logbooks and COC forms to ensure sample collection was performed per the plan. Determine impacts of any deviations of sample collection.	SPM or designee, Millennium
Ila	COC Forms	Examine COC forms against SAP requirements such as analytical methods, sample identification, etc.	SPM or designee, Millennium
Iib	Laboratory Data packages	Examine laboratory package against SAP requirements and COC forms (sample identification, holding times, quality control samples, field duplicates, analytical methods, reporting limits, etc.).	Laboratory QA, TBD
Iib	Laboratory Data packages	Determine impacts of any deviations or quality issues associated with analytical data.	Laboratory QA, TBD
Iib	Data validation reports	Determine impacts of any deviations or quality issues associated with analytical data.	PHP/ Tetra Tech

Notes: 90% of the data packages will receive cursory validation and 10% of the data packages will receive full validation.

1 Ila=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]  
Iib=comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

COC Chain of Custody  
PHP Project Health Physicist  
SAP Sampling and Analysis Plan  
SPM Subcontract Project Manager  
TBD To Be Determined

**SAP WORKSHEET #36 –ANALYTICAL DATA VALIDATION (STEPS IIA AND IIB)**  
**SUMMARY TABLE**  
(UFP-QAPP Manual Section 5.2.2.1)(Worksheet #37)

Step Ila / I Ib	Matrix	Analytical Group	Validation Criteria <sup>1,2</sup>	Data Validator
Ila and I Ib	Soil Sediment Solids	Gamma Emitting Isotopes	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA
Ila and I Ib	Soil Sediment Solids	Total Sr	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA
Ila and I Ib	Soil Sediment Solids	Alpha Emitting Isotopes	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA
Ila and I Ib	Swipes	Tritium (H-3)	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA

Notes: 90% of the data packages will receive cursory validation and 10% of the data packages will receive full validation.

- 1 All laboratory data will be validated in accordance with the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) [NUREG-1576]. The data validation strategy will be consistent with Navy guidelines. Data validation will also take into consideration the measurement criteria specified in this SAP. See Worksheet #37 for description of validation qualification flags.
- 2 Data validation SOPs can be found in Attachment 3 of the management plan.

H-3 Tritium  
QA Quality Assurance  
Sr Strontium

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT**

(UFP-QAPP Manual Section 5.2.3)

### **37.1 RECONCILIATION WITH USER REQUIREMENTS**

After environmental data have been reviewed, verified, and validated in accordance with the procedures, the data must be further evaluated to determine whether DQOs have been met.

To the extent possible, Tetra Tech will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's "Guidance for Data Quality Assessment, Practical Methods for Data Analysis" (EPA 2000a). The DQA process includes five steps: (1) review the DQOs and sampling design; (2) conduct a preliminary data review; (3) select a statistical test; (4) verify the assumptions of the statistical test; and (5) draw conclusions from the data.

Tetra Tech will systematically assess data quality and data usability when the five-step DQA process is not completely followed because the DQOs are qualitative. This assessment will include the following:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives
- A review of project-specific data quality indicators for precision, accuracy, representativeness, completeness, and comparability (PARCC) and quantitation limits to evaluate whether acceptance criteria have been met
- A review of project-specific DQOs to determine whether they have been achieved by the data collected
- An evaluation of any limitations associated with the decisions to be made based on the data collected.

The final report for the project will discuss any potential impacts of these reviews on data usability and will clearly define any limitations associated with the data.

### **37.2 MEASUREMENT QUALITY OBJECTIVES**

All analytical results will be evaluated during data validation in accordance with PARCC parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the project objectives. The data validation process was described in greater detail in [Worksheet #36](#).

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)**

The following subsections describe each of the PARCC parameters and how they will be assessed within this project.

### **37.2.1 Precision**

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision are evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a RPD:

$$RPD = \frac{|A - B|}{(A + B)/2} \times 100$$

Where:

- A = First duplicate concentration  
B = Second duplicate concentration

Field sampling precision is evaluated by analyzing field duplicate samples.

Laboratory analytical precision is evaluated by comparing analytical results of field samples with those of field duplicates, laboratory matrix duplicates, or by analyzing MS of field samples along with MSD. For this project, MS/MSD samples will be generated for all organic analytes. MS/MSDs or matrix duplicates will be used to assess precision for inorganic analytes. The results of the analysis of each MS/MSD or duplicate pair will be used to calculate an RPD for evaluating precision. [Worksheet #28](#) presents the precision goals for this project.

### **37.2.2 Accuracy**

Field accuracy will be assessed by collecting and analyzing equipment rinsate and source water blank QC samples. These QC samples will be used to evaluate the potential for target analytes to enter samples as a result of sampling processes.

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, LCS or blank spikes, surrogate standards, and method blanks. MS samples will be prepared and analyzed at a frequency of 5 percent for samples that will require analysis for inorganic chemicals. LCS or blank spikes are also analyzed at a frequency of 5 percent or per extraction batch, whichever is most frequent. Surrogate standards, where available, are added to every sample analyzed for organic constituents. The results of the spiked samples are used to calculate the percent recovery (%R) for evaluating accuracy.

## SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)

$$\text{Percent Recovery} = \frac{S - C}{T} \times 100$$

Where:

S = Measured spike sample concentration  
C = Sample concentration  
T = True or actual concentration of the spike

[Worksheet #28](#) presents accuracy goals for this investigation based on the percent recovery of laboratory, matrix, and surrogate spikes. Results that fall outside the accuracy goals will be evaluated further on the basis of the results of other QC samples.

### 37.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will also be ensured through consistent application of established field and laboratory procedures. Laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be nonrepresentative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

For this project the representativeness of samples will be evaluated in part by judging whether samples a sufficient number and type of samples have been collected from locations that are most likely to have been contaminated. This judgment will be applied during sampling by the samplers and the SPM.

### 37.2.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)**

As discussed further in [Section 37.2](#), completeness will also be evaluated as part of the data quality assessment process ([EPA 2000a](#)). This evaluation will help determine whether any limitations are associated with the decisions to be made based on the data collected.

### **37.2.5 Comparability**

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data. Field procedures will be standardized to ensure comparability. The comparability of laboratory data will be assured by use of established and approved analytical methods, consistency in the basis of analysis (wet weight, volume, or similar units), and consistency in reporting units (parts per million, parts per billion, and so forth).

### **37.2.6 Sensitivity - Detection and Quantitation Limits**

The minimum detectable activity (MDA) is the smallest level of radioactivity in a sample that can be reliably distinguished from ambient background. The quantitation limit represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a specific sample matrix. QLs are laboratory-specific quantitation limits for specific analytical methods and sample matrices, such as soil or water, and are typically several times higher than the MDL to allow for matrix effects. PALs, which are established by Tetra Tech in the scope of work for subcontract laboratories, are set to establish minimum criteria for laboratory performance; actual laboratory quantitation limits may be substantially lower.

Analytical methods have been selected for this project so that the QL for each target analyte is below the QL wherever practical. [Worksheet #15](#) compares the PALs for the selected analytical methods with QLs. The QLs listed reflect the maximum sensitivity of current, routinely used analytical methods. All analytes will be reported as estimated values if concentrations are less than PQLs but greater than MDAs. This procedure is being adopted to help ensure that analytical results can effectively be compared with comparison criteria for certain compounds where the screening criteria are near or below the PAL. This procedure also will help to ensure that subsequent statistical evaluations of the data will not be biased by high-value nondetect results.

#### **Minimum Detectable Activity (MDA)**

The minimum detectable activity (MDA) is defined as the smallest level of radioactivity in a sample that can be detected with a 5% probability of erroneously detecting radioactivity, when in fact none was present (Type I error) and also, a 5% probability of not detecting radioactivity, when in fact it is present (Type II error). MDA is often used interchangeably with minimum detectable concentration (MDC), since the difference between the two terms is only one of unit

## SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)

conversion. MDA/MDC is a function of ambient background radiation and counting time. MDA/MDC can be calculated using the following equation:

$$MDA (MDC) = \frac{3 + 3.29 \sqrt{R_b t_b \left(\frac{t_s}{t_b}\right)}}{(eff)(t_s)}$$

Where:

MDA (MDC) = Minimum Detectable Activity (Minimum Detectable Concentration)

$R_b$  = background counting rate

$t_b$  = background counting time

$t_s$  = sample counting time

eff = instrument efficiency

### 37.2.7 Data Usability

Although some qualifiers may be added to the data, a final review of the data set against the EPA data quality parameters will be used to determine if data meet all the requirements of the precision, accuracy, representativeness, completeness, and comparability described in EPA guidance for quality assurance project plans ([EPA 2002](#)), the DoD QSM, and this SAP.

EPA “Risk Assessment Guidance for Superfund” (RAGS) will be used to evaluate the usability of the validated data ([EPA 1989](#)). Chapter 5, Exhibit 5-5 in RAGS states that data qualified as estimated (J) based on data validation reports should be used in quantitative risk assessments. Although this guidance is specifically for human health risk assessments, the same usability criteria will be applied for all the data. Only data qualified as rejected (R) are considered unusable for risk assessment. Accordingly, all J-qualified data, but no R-qualified data, will be used for this investigation.

After completion of the data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and the proportion of samples with detected and non-detected results. The project team members identified by the Tetra Tech PM will assess whether the data collectively support the attainment of project objectives. They will consider whether any missing or rejected data have compromised the ability to make decisions or to make the decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated by other data. Although rejected data will generally not be used, there may be reason to use them in a

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)**

weight of evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

### **Data Validation Qualifiers**

Assignment of data qualification flags will conform to EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (2008) and Inorganic Data Review (2004). Data validation specifications require that various data qualifiers be assigned when a deficiency is detected or when a result is less than its detection limit. If no qualifier is assigned to a result that has been validated, the data user is assured that no technical deficiencies were identified during validation. The qualification flags used are defined as follows:

- U – Indicates that the chemical was not detected at the numerical detection limit (sample-specific detection limit) noted. Non-detected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.
- UJ – Indicates that the chemical was not detected; however, the detection limit (sample-specific detection limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.
- J – Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of the concentration that is actually present in the sample. The laboratory reported concentration is considered to be an estimate of the true concentration.
- R – Indicates that the chemical may or may not be present. The non-detected analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (for example, a holding time missed by a factor of two times the specified time limit, severe calibration non-compliance, or extremely low analyte recovery in QC spike samples).

The results of data validation will be presented in a quality control summary report (QCSR). The QCSR section will be included in all versions of the Final Status Survey Report. If, during data validation, non-conformances are identified, the project health physicist will immediately notify the Tetra Tech Project Manager and QAM, and the Navy RPM.

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Tetra Tech, Inc. (Tetra Tech). 2013. "Basewide Radiological Management Plan, Naval Air Station Joint Reserve Base Willow Grove, Pennsylvania". Prepared for the Base Realignment and Closure Program. May.



**Draft**

**Sampling and Analysis Plan  
(Field Sampling Plan and Quality Assurance)  
for Basewide Radiological Surveys**

**Naval Air Station Joint Reserve Base  
Willow Grove  
Willow Grove, Pennsylvania**

**August 2013**

Prepared for:

**Department of the Navy  
Base Realignment and Closure  
Program Management Office East  
Philadelphia, Pennsylvania**

Prepared by:

**Tetra Tech, Inc.  
661 Anderson Drive, Suite 5  
Pittsburgh, Pennsylvania**

Prepared under:

**Naval Facilities Engineering Command  
Contract Number N62470-08-D-1001  
Contract Task Order WE42**

## SAP WORKSHEET #1 – TITLE AND APPROVAL PAGE

**DRAFT**  
**SAMPLING AND ANALYSIS PLAN**  
**(Field Sampling Plan and Quality Assurance Project Plan)**

**BASEWIDE RADIOLOGICAL SURVEYS**  
**NAVAL AIR STATION JOINT RESERVE BASE WILLOW GROVE**  
**WILLOW GROVE, PENNSYLVANIA**

**August 2013**

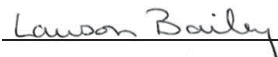
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Tetra Tech, Inc.  
661 Anderson Drive, Suite 5  
Pittsburgh, Pennsylvania

**Prepared under:**  
Naval Facilities Engineering Command  
Contract Number N62470-08-D-1001  
Contract Task Order WE42

### Review Signatures:

Lawson Bailey  
Project Manager  
Tetra Tech, Inc.



Tom Johnston  
Quality Assurance Manager  
Tetra Tech, Inc.



### Approval Signatures:

Brian Helland  
Remedial Project Manager  
NAVFAC MIDLANT

**HELLAND.BRIA**  
**N.J.1231396710**  
Digitally signed by  
HELLAND.BRIAN.J.1231396710  
DN: c=US, o=U.S. Government, ou=DoD,  
ou=PKI, ou=USN,  
cn=HELLAND.BRIAN.J.1231396710  
Date: 2013.08.13 16:00:52 -04'00'

## EXECUTIVE SUMMARY

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This Sampling and Analysis Plan (SAP) was developed to support the Basewide Radiological Management Plan ([Tetra Tech 2013](#)) for Basewide Radiological Surveys at Naval Air Station (NAS) Joint Reserve Base (JRB) Willow Grove, Willow Grove, Pennsylvania. The SAP addresses the objectives, procedures, functional activities, and specific quality assurance and quality control activities associated with planned field activities in support of radiological surveys of potentially impacted buildings at NAS JRB Willow Grove. This document constitutes the planning document, addressing specific protocols for sample collection, sample handling and storage, chain-of-custody, laboratory and field analyses, data validation, and data reporting. The requirements of this SAP are applicable to all project personnel, project support groups, contractors, and subcontractors.

The overall project is being managed by Tetra Tech, Inc., as the prime contractor under Contract Number N62470-08-D-1001 with the Naval Facilities Engineering Command Mid-Atlantic (NAVFAC MIDLANT). Tetra Tech, Inc. (Tetra Tech) has prepared this SAP on behalf of the Base Realignment and Closure Program Management Office. This SAP complies with applicable Department of the Navy, Pennsylvania, and U.S. Environmental Protection Agency (EPA) Region 3 requirements, regulations, guidance and technical standards, especially EPA and U.S. Department of Defense (DoD), U.S. Department of Energy (DOE), and EPA ([2005](#)). To comply with DoD, DOE and EPA ([2005](#)) requirements, the SAP is presented in the format of standard worksheets specified in the Uniform Federal Policy Quality Assurance Project Plan.

Operations involving radioactive material were performed at NAS JRB Willow Grove from 1943 through 2011. All naval operations at NAS JRB Willow Grove officially terminated in September 2011. The Navy prepared a Historical Radiological Assessment (HRA) to identify potentially impacted sites at NAS JRB Willow Grove (Tetra Tech, Inc. [[Tetra Tech](#)] [2012](#)). The HRA ([Tetra Tech 2012](#)) identified an impacted site as a site that has, or historically had, a potential for General Radioactive Material contamination based on the site operating history or known contamination detected during previous radiation surveys. A designation of “impacted” does not confirm that radioactive contamination is present, only that the possibility exists and must be investigated.

The overall conclusion of the HRA ([Tetra Tech 2012](#)) was that low levels of radioactive contamination potentially exist within the confines of NAS JRB Willow Grove. The levels of radiation associated low level radioactive contamination potentially represent an unacceptable level of risk for certain receptors and exposures scenarios such as a resident living on site.

The scope for this project is to perform radiological surveys, in the form of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Scoping Surveys (Nuclear Regulatory Commission [[NRC](#)] [2000](#)), in parts of nine buildings and three Installation Restoration Program (IRP) sites to further characterize the radiation levels and exposure potential for various human receptors. Additional buildings may be added depending on the

approval of the HRA ([Tetra Tech 2012](#)). In addition, removal of contaminated materials may be recommended with the intent of reducing potentially unacceptable exposures to acceptable levels

The fifteen buildings and three IRP sites that will be surveyed during this project include the following:

- Building 4
- Building 18
- Building 20
- Building 22
- Building 23
- Building 29
- Building 77
- Building 80
- Building 118
- Building 140
- Building 175
- Building 177
- Bunker 180
- Bunker 601
- Bunker 680
- IR Site 1
- IR Site 3
- IR Site 12

The actions to be performed include the following:

- Scanning measurements
- Static measurements, as applicable
- Removable contamination measurements, as applicable
- Soil Sampling (IR sites)
- Floor drain sediment sampling (if necessary)
- Survey and removal of potentially contaminated floor tiles

Scanning and static measurements of building and site surfaces and systematic soil sampling at IR sites will be performed to determine if residual contamination is present in excess of the Derived Concentration Guideline Level (DCGL). Additionally, swipe samples of building surfaces will be collected to establish presence or absence of removable contamination and sediment samples from floor drains will be collected to determine if residual radioactive material is present in the drains. The results of these investigations are intended to provide technically sound and sufficient data and information to determine if the buildings can be radiologically free released or if further remedial actions are warranted. The site-specific survey requirements for addressing these measurements will be contained in the task specific plans (TSP). The TSPs are not a part of the SAP and will be prepared and approved by the Navy prior to performing field activities at buildings. A detailed description of the TSP process can be found in Section 3.3.1 of the management plan. The final evaluations could result in radiological free release of the potentially impacted areas, identification of contaminated areas for future remediation, or further investigations to more adequately characterize the nature and extent of contamination.

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## **ACRONYMS AND ABBREVIATIONS**

---

%R	Percent recovery
AEC	United States Atomic Energy Commission
ANSI	American National Standards Institute
ATC	Air Traffic Control
BEC	BRAC Environmental Coordinator
BRAC	Base Realignment and Closure
CA	Corrective action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm <sup>2</sup>	Centimeters squared
Co-60	Cobalt 60
COC	Chain-of-custody
Cs-137	Cesium-137
CSO	Caretaker site office
DCGL	Derived concentration guideline level
DEP	Pennsylvania Department of Environmental Protection
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
dpm	Disintegrations per minute
DQA	Data Quality Assessment
DQI	Data quality indicator
DQO	Data quality objective
DU	Depleted uranium
EDD	Electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EPM	Environmental Program Manager
FedEx	Federal Express
ft <sup>2</sup>	Square feet
FSS	Final status survey
FTMR	Field task modification request
GEMD	Ground Electronic Maintenance Division
GFPC	Gas Flow Proportional Counter
GM	Geiger-Mueller
H-3	Tritium
HASP	Health and Safety Plan
HLRA	Horsham Land Redevelopment Authority

## ***ACRONYMS AND ABBREVIATIONS (CONTINUED)***

---

HPGe	High Purity germanium
HRA	Historical Radiological Assessment
IDW	Investigation-derived waste
IRP	Installation Restoration Program
JPEG	Joint photographic experts group
JRB	Joint Reserve Base
LCS	Laboratory control sample
LLRW	Low level radioactive waste
M&E	Material and Equipment
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum detectable concentration
MDL	Method detection limit
MIDLANT	Mid-Atlantic
mL	Milliliter
MPC	Measurement performance criteria
mrem/y	Millirem per year
MS/MSD	Matrix spike/matrix spike duplicate
MSI	Millennium Services, Inc.
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NEDD	Navy electronic data deliverable
NFESC	Naval Facilities Engineering Service Center
NIRIS	Naval Installation Restoration Information Solution
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PAL	Project Action Limit
PARCC	Precision, accuracy, representativeness, completeness, and comparability
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
PHP	Project Health Physicist
PM	Project Manager
PMO	Program Management Office
PPE	Personal protective equipment
PQL	Project Quantitation Limit
PRSO	Project radiation safety officer

## **ACRONYMS AND ABBREVIATIONS (CONTINUED)**

---

QA	Quality assurance
QAM	Quality Assurance Manager or Quality Assessment Manual
QAPP	Quality assurance project plan
QC	Quality control
QCSR	Quality Control Summary Report
QL	Quantitation limit
QSM	Quality Systems Manual
Ra-226	Radium 226
RASO	Radiological Affairs Support Office
RCRA	Resource Conservation and Recovery Act
RE	Radiological Engineer
RL	Reference Limit
ROC	Radionuclide of concern
ROICC	Resident officer in charge of construction
RPD	Relative percent difference
RPM	Remedial Project Manager
RSOR	Radiation Safety Officer Representative
SAP	Sampling and analysis plan
SCM	Surface contamination monitor
SD	Standard Deviation
SDG	Sample delivery group
SOP	Standard operating procedure
SOW	Statement of work
SPM	Subcontract Project Manager
Sr-90	Strontium 90
SS	Site Supervisor
SSO	Site Safety Officer
TBD	To be determined
Tetra Tech	Tetra Tech, Inc.
Th-232	Thorium 232
TSP	Task specific plan
U-238	Uranium 238
UFP	Uniform Federal Policy
UO <sup>2</sup>	Uranium oxide
USAEC	U.S. Atomic Energy Commission
WW	World War
y	Year

## SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION

(UFP-QAPP Manual Section 2.2.4)

**Site Name/Number:** Naval Air Station (NAS) Joint Reserve Base (JRB) Willow Grove  
**Operable Unit:** Basewide  
**Contractor Name:** Tetra Tech, Inc.  
**Contract Number:** N62470-08-D-1001  
**Contract Title:** Comprehensive Long-Term Environmental Action Navy (CLEAN)  
**Contract Task Order:** WE42

1. This sampling and analysis plan (SAP) was prepared in accordance with the requirements of the Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP) (U.S. Environmental Protection Agency [EPA] 2005) and EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (EPA 2002).
2. Identify regulatory program: CERCLA
3. Identify Approval Entity: Naval Facilities Engineering Command Mid-Atlantic (NAVFAC MIDLANT)
4. This SAP is a project-specific SAP.

List dates of scoping sessions that were held:

SCOPING SESSION	DATE
Teleconference with BRAC PMO NE and Radiological Affairs Support Office (RASO)	2/15/13

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

TITLE	DATE
No SAP documents have been generated for previous site work.	

## **SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION (CONTINUED)**

6. List organizational partners (stakeholders) and connection with lead organization  
Radiological Affairs Support Office (RASO), Supporting Organization (lead agency stakeholder)  
Base Realignment and Closure (BRAC) Program Management Office (PMO) East, Supporting Organization (lead agency stakeholder)  
U.S. Environmental Protection Agency, Region III (EPA) (regulatory stakeholder)  
Pennsylvania Department of Environmental Protection (DEP) (regulatory stakeholder)  
Horsham Land Redevelopment Authority (HLRA) (stakeholder)
7. Lead organization  
  
NAVFAC MIDLANT
8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

## SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION (CONTINUED)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
<b>A. Project Management</b>		
<i>Documentation</i>		
1	Title and Approval Page	
2	Table of Contents SAP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
<i>Project Organization</i>		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	
<i>Project Planning/ Problem Definition</i>		
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background Site Maps (historical and present)	
11	Site-Specific Data Quality Objectives	
12	Measurement Performance Criteria (MPC) Table	
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	Not applicable; No secondary data used in developing this SAP
14	Summary of Project Tasks	
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
<b>B. Measurement Data Acquisition</b>		
<i>Sampling Tasks</i>		
17	Sampling Design and Rationale	
18	Sampling Locations and Methods/ Standard Operating Procedure (SOP) Requirements Table Sample Location Map(s)	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	

## SAP WORKSHEET #2 – SAP IDENTIFYING INFORMATION (CONTINUED)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
<i>Analytical Tasks</i>		
23	Analytical SOPs Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	
<i>Sample Collection</i>		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	
<i>Quality Control Samples</i>		
28	Quality Control (QC) Samples Table Screening/Confirmatory Analysis Decision Tree	
<i>Data Management Tasks</i>		
29	Project Documents and Records Table	
30	Analytical Services Table Analytical and Data Management SOPs	
<b>C. Assessment Oversight</b>		
31	Planned Project Assessments Table Audit Checklists	
32	Assessment Findings and Corrective Action Responses Table	
33	Quality Assurance (QA) Management Reports Table	
<b>D. Data Review</b>		
34	Verification (Step I) Process Table	
35	Validation (Steps IIa and IIb) Process Table	
36	Validation (Steps IIa and IIb) Summary Table	
37	Usability Assessment	

**SAP WORKSHEET #3 – DISTRIBUTION LIST**  
 (UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Willington Lin	BRAC Environmental Coordinator	BRAC PMO East	215-897-4904	<a href="mailto:willie.lin@navy.mil">willie.lin@navy.mil</a>
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Patrick Owens	Environmental Program Manager (EPM)	Naval Sea Systems Command Detachment, RASO	757-887-7644	<a href="mailto:patrick.a.owens@navy.mil">patrick.a.owens@navy.mil</a>
Martin Schy	Caretaker Site Officer (CSO)	BRAC PMO East	215-293-4888	<a href="mailto:martin.schy@navy.mil">martin.schy@navy.mil</a>
Lisa Cunningham	RPM	EPA	215-814-3363	<a href="mailto:cunningham.lisa@epa.gov">cunningham.lisa@epa.gov</a>
Margaret Pollich	Project Officer	PADEP	484-250-5731	<a href="mailto:mpollich@pa.gov">mpollich@pa.gov</a>
TBD	Radiation Program Manager	PADEP-BRP	TBD	TBD
Lawson Bailey	Project Manager (PM)/Project Health Physicist (PHP)/Radiation Safety Officer Representative (RSOR)/ Site Safety Officer (SSO)	Tetra Tech	803-641-6326	<a href="mailto:lawson.bailey@tetrattech.com">lawson.bailey@tetrattech.com</a>
Dick Dubiel	Subcontract Project Manager (SPM)/ Radiological Engineer (RE)	Millennium	678-296-4813	<a href="mailto:ddubiel@millserv.com">ddubiel@millserv.com</a>
TBD	Site Supervisor (SS)	Millennium	TBD	TBD
Heather Shaffer	Laboratory PM	GEL	843-556-8171	<a href="mailto:heather.shaffer@gel.com">heather.shaffer@gel.com</a>
Joe Samchuck	Data Validation	Tetra Tech	412-921-8510	<a href="mailto:joseph.samchuck@tetrattech.com">joseph.samchuck@tetrattech.com</a>
Erik Abkemeier	Project Radiation Safety Officer (PRSO)	Tetra Tech	757-466-4906	<a href="mailto:erik.abkemeier@tetrattech.com">erik.abkemeier@tetrattech.com</a>

### SAP WORKSHEET #3 – DISTRIBUTION LIST (CONTINUED)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Tom Johnston (electronic copy)	Quality Assurance Manager (QAM)	Tetra Tech	412-921-8615	<a href="mailto:tom.johnston@tetrattech.com">tom.johnston@tetrattech.com</a>

Notes:

BRAC	Base Realignment and Closure
CSO	Caretaker Site Officer
EPA	Environmental Protection Agency
EPM	Environmental Program Manager
NAVFAC MIDLANT	Naval Facilities Engineering Command Mid-Atlantic
PADEP	Pennsylvania Department of Environmental Protection
PHP	Project Health Physicist
PM	Project Manager or Program Manager
PMO	Program Management Office

PRSO	Project Radiation Safety Officer
QAM	Quality Assurance Manager
RASO	Radiological Affairs Support Office
RE	Radiological Engineer
RPM	Remedial Project Manager
SPM	Subcontract Project Manager
SS	Site Supervisor
SSO	Site Safety Officer

## SAP WORKSHEET #4 – PROJECT PERSONNEL SIGN-OFF SHEET

(UFP-QAPP Manual Section 2.3.2)

The Project Personnel Sign-off Sheet documents that all key project personnel performing work have read this site-specific SAP and will carry out the tasks as described. The sign-off sheet, which will be included in the central project file, will be signed by all on-site personnel after they read the SAP. However, if only a portion of the SAP was reviewed, then personnel will note which sections were reviewed on the sign-off sheet.

Name	Organization Title/Role	Telephone Number (optional)	Signature/e-mail receipt	SAP Section Reviewed	Date SAP Read
Brian Helland	Navy, RPM/ Manages project activities for the Navy	215-897-4912		All	
Margaret Pollich	PADEP, PO/Provides regulator input	484-250-5731		All	
Lawson Bailey	Tetra Tech, PM/ Manages project activities	803-641-6326	See <a href="#">Worksheet #1</a> for signature	All	
Lawson Bailey	Tetra Tech, PHP/ Designated overview of health physics activities	803-641-6326	See <a href="#">Worksheet #1</a> for signature	All	
Erik Abkemeier	Tetra Tech, PRSO/ Manages project safety and required licenses	757-466-4906		All	
Tom Johnston	Tetra Tech CLEAN QAM/ Manager NAVFAC LANT Contract QA Program and Implementation	412-921-8615	See <a href="#">Worksheet #1</a> for signature	All	
Dick Dubiel	Millennium - SPM/RE	678-296-4813		All	
TBD	Millennium - SS	TBD		All	
Lawson Bailey	Site Safety Officer (SSO)	803-641-6326	See <a href="#">Worksheet #1</a> for signature	All	
Kelly Carper	Tetra Tech, Project Chemist/ Provides coordination with laboratories	412-921-7273		All	

## SAP WORKSHEET #4 – PROJECT PERSONNEL SIGN-OFF SHEET (CONTINUED)

Name	Organization Title/Role	Telephone Number (optional)	Signature/e-mail receipt	SAP Section Reviewed	Date SAP Read
Heather Schaffer	GE:, Laboratory PM/ Representative for laboratory and analytical issues	843-769-7386		Worksheets 11, 12, 15, 19, 20, 23, 24, 25, 28, 30, 34, 35, 36, and 37	
Joe Samchuck	Data Validation Manager/ Manages Data Validation	412-921-8510		Worksheets 11, 12, 15, 19, 20, 23, 24, 25, 28, 30, 34, 35, 36, and 37	

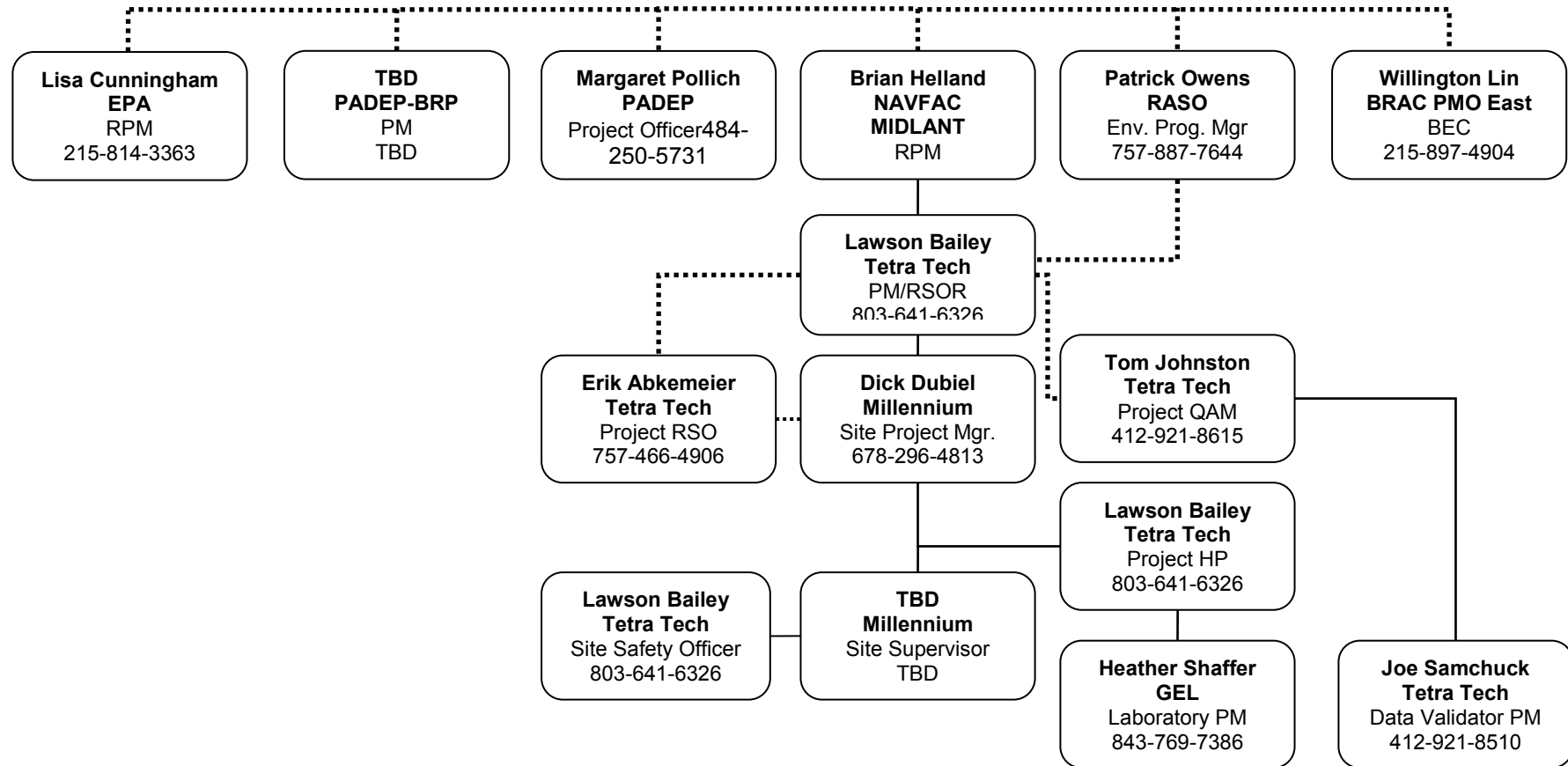
Notes:

PHP Project Health Physicist  
PO Project Officer  
PRSO Project Radiation Safety Officer  
PM Project Manager

QAM Quality Assurance Manager  
RE Radiological Engineer  
SPM Subcontract Project Manager  
SS Site Supervisor

## SAP WORKSHEET #5 – PROJECT ORGANIZATIONAL CHART

(UFP-QAPP Manual Section 2.4.1)



Lines of Authority —————

Lines of Communication ..... (Dotted Line)

## SAP WORKSHEET #6 – COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Notice to proceed	Navy RPM	Brian Helland	215-897-4912	Navy RPM will review and approve project management plans, and communicate directly with contractor on all aspects of project management. Navy RPM will also coordinate with appropriate personnel in the event that changes require additional approvals or authorizations within 7 business days (letter of notice to proceed or via e-mail).
Coordination of off-site laboratory services	PHP Laboratory PM	Lawson Bailey TBD	803-641-6326 TBD	The PHP or designee will coordinate all activities requiring off-site laboratory support, including, delivery of necessary sample containers and appropriate shipping materials (such as coolers and bubble wrap) on site prior to commencement of field sampling activities and within 24-48 hours after each sampling event (verbally or via e-mail to the Laboratory PM).
Field and analytical corrective actions	QAM PM Navy RPM	Tom Johnston Lawson Bailey Brian Helland	412-921-8615 803-641-6326 215-897-4912	The Tetra Tech QAM will notify the PM verbally or by e-mail within one business day that the corrective action has been completed.  The PM will then notify the Navy RPM within one business day.
Field task modification requests (FTMR)	SS	TBD	TBD	The SS will document the change via an FTMR form within two days of identifying the need for change and will obtain required approvals within five days of initiating the form.
SAP amendments	PM SPM Navy RPM RASO	Lawson Bailey Dick Dubiel Brian Helland Patrick Owens	803-641-6326 678-296-4813 215-897-4912 757-887-7644	The SPM will verbally inform the PM within 24 hours of realizing a need for an amendment.  The PM will document the proposed changes via a Field Task Modification Request (FTMR) form within five days and send the Navy RPM a concurrence letter within seven days of identifying the need for change.  SAP amendments will be submitted by the PM to the Navy RPM for review and approval.

## SAP WORKSHEET #6 – COMMUNICATION PATHWAYS (CONTINUED)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
				RASO concurrence required on all SAP amendments.  The PM will send scope changes to the Project Team via e-mail within one business day.
Changes in schedule	PM SPM	Lawson Bailey Dick Dubiel	803-641-6326 678-296-4813	The PM will verbally inform the Navy RPM on the day that schedule change is known and document via schedule impact letter within one business day of when impact is realized.
Issues in the field that result in changes in scope	SPM PM Navy RPM RASO	Lawson Bailey Dick Dubiel Brian Helland Patrick Owens	803-641-6326 678-296-4813 215-897-4912 757-887-7644	The SPM will verbally inform the PM on the day that the issue is discovered.  The PM will inform the Navy RPM (verbally or via e-mail) within one business day of discovery.  The Navy RPM will issue scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed.  The PM will document the change via an FTMR form within two days of identifying the need for change and will obtain required approvals within five days of initiating the form.  RASO must concur, via e-mail or verbal communication, on all radiological changes in scope.
Recommendations to stop work <sup>1</sup> and initiate work upon corrective action	SS SSO PM Tetra Tech QAM SPM Navy RPM	TBD Lawson Bailey Lawson Bailey Tom Johnston Dick Dubiel Brian Helland	860-844-4430 803-641-6326 803-641-6326 412-921-8615 678-296-4813 215-897-4912	If Tetra Tech is the responsible party for a stop work command, the SS will inform onsite personnel, subcontractor(s) and the identified Project Team members within one hour (verbally or by e-mail).  If a subcontractor is the responsible party, the subcontractor PM must inform the SS within 15 minutes, and the SS will then follow the procedure listed above.
Analytical data quality issues	Laboratory PM Tetra Tech Project Chemist	Heather Shaffer Kelly Carper	843-769-7386 412-921-7273	The Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within one business day of when an issue related to laboratory data is discovered.

## SAP WORKSHEET #6 – COMMUNICATION PATHWAYS (CONTINUED)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
				<p>The Tetra Tech Project Chemist will notify (verbally or via e-mail) the data validation staff and the PM within one business day.</p> <p>The Tetra Tech PM will notify the Navy RPM (verbally or via e-mail) of significant data quality issues within 1 business day of resolution.</p>
Review of analytical data and concurrence on radiological actions	RASO PM	Patrick Owens Lawson Bailey	757-887-7644 803-641-6326	<p>The PM will then notify the Navy RPM within one business day that data is available for review.</p> <p>RASO will verify concurrence of radiological actions within one business (via e-mail).</p>
SAP procedure revision during field activities	SPM PM	Dick Dubiel Lawson Bailey	678-296-4813 803-641-6326	The PM will then notify the Navy RPM within one business day.

Notes:

- 1 All site personnel have the ability to stop work if they deem that unsafe conditions exist or if procedural guidance is being exceeded.

FTMR Field Task Modification Request  
 PHP Project Health Physicist  
 PM Project Manager  
 QA/QC Quality Assurance/Quality Control  
 RASO Radiological Affairs Support Office

RE Radiological Engineer  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager  
 SS Site Supervisor  
 SSO Site Safety Officer

**SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE**  
 (UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Patrick Owens	EPM	RASO	<ul style="list-style-type: none"> <li>Provides government oversight of the QA program, including review and sign-off on SAPs and any future modifications to the plans</li> <li>Provides quality-related direction to the Navy RPM and the Tetra Tech QAM</li> <li>Has authority to suspend affected project or site activities if approved quality requirements are not adequately met</li> <li>Reviewing radiological laboratory and field survey data on a routine basis</li> <li>Performing on-site reviews of all radiological site operations</li> <li>Reviewing and approving TSPs and final status survey reports</li> <li>Performing quality reviews on radionuclides of concern (ROC) to ensure samples are handled in accordance with the management plan and SAP</li> <li>Providing review and concurrence on data for proposed radiological actions</li> <li>Ensuring that all necessary sample results are provided and are consistent with proposed radiological actions</li> <li>Comparing radiological data with the requirements of the management plan, SAP, and TSPs, to ensure that all proper conditions have been met to implement the action requested</li> <li>Ensuring that the radiological data reported is consistent with the intent for which the data was provided</li> <li>Comparing the sample number matrix with the intent of the data package to ensure that the sample number is consistent with the intent of the data package</li> <li>Reviewing sample acquisition information to ensure that the duration the sample was analyzed for meets the minimum required time necessary to meet the minimum detectable concentration (MDC)</li> <li>Comparing each of the radionuclides' specific activity with the release criteria to ensure that the decision made is consistent with the specific activity reported</li> <li>Comparing the MDC with the release criteria to ensure that it is below the release levels</li> <li>Evaluating the qualifiers provided in the sample results to ensure that the information provided is consistent with the results provided</li> <li>Reviewing uncertainty counting and the 2 sigma total uncertainty data along with the laboratory qualifiers to determine if the data can be used</li> </ul>
Brian Helland	Navy RPM	BRAC PMO E	<ul style="list-style-type: none"> <li>Performing project management for the Navy</li> <li>Ensuring that the project scope of work requirements are fulfilled</li> <li>Overseeing the project cost and schedule</li> <li>Providing formal technical direction to the contractor project team, as needed</li> <li>Acting as lead interface with agencies</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
Lawson Bailey	PM	Tetra Tech	<ul style="list-style-type: none"> <li>Coordinating work activities of contractor and subcontractor personnel and ensuring that all personnel adhere to the administrative and technical requirements of the project</li> <li>Monitoring and reporting the progress of work and ensuring that the project deliverables are completed on time and within project budget</li> <li>Monitoring the budget and schedule and notifying the client and the RPM of any changes that may require administration actions</li> <li>Ensuring adherence to the quality requirements of the contract, project scope of work, and the SAP</li> <li>Ensuring that all work meets the technical requirements of task specific plans (TSPs) and complies with applicable codes and regulations</li> <li>Ensuring that all work activities are conducted in a safe manner in accordance with the Site Health and Safety (HASP) and all applicable Occupational Safety and Health Administration (OSHA) regulations</li> <li>Serving as the primary contact between the Navy and Tetra Tech for actions and information related to the work and including appropriate Tetra Tech or subcontractor personnel in the decision making</li> </ul>
Dick Dubiel	SPM	Millennium	<ul style="list-style-type: none"> <li>Responsible for technical direction to the onsite organization regarding data collection methodology</li> <li>Responsible to ensure adequate resources are provided to implement this management plan and TSPs</li> <li>Works directly with the SS and RE during implementation of on-site activities.</li> <li>Responsible for the quality review of data generated from field activities. The quality review can be delegated, provided it is delegated to an individual who has not been directly involved in the generation or processing of the field data.</li> <li>Responsible for communicating directly with the PM regarding field issues including schedule adherence, survey results and quality issues</li> <li>If changes are necessary, the SPM is responsible for communicating the changes via phone and/or e-mail to project staffs and is authorized to stop work if necessary.</li> <li>Inform Navy via schedule impact letter as soon as impact is realized and scope identified.</li> <li>Responsible for the preparation of FTMR for any changes in project procedures that occur due to conditions in the field.</li> <li>Assists in the performance of field sampling system audits</li> <li>Prepares field data validation report (weekly)</li> <li>Prepares Project monthly progress report</li> <li>Reviews weekly and verifies that the field logbook information is complete</li> <li>Assists in the review of laboratory data</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
Lawson Bailey	Project Health Physicist (PHP)	Tetra Tech	<ul style="list-style-type: none"> <li>Assisting in the development and approval of the management plan, SAP, TSPs and HASP</li> <li>Assisting in identifying radiological analysis needs</li> <li>Providing technical support for field activities</li> <li>Providing health physics guidance on an as-needed basis</li> <li>Providing radiological control protection services, if required</li> <li>Directing and assisting project personnel in proper completion of radiological records</li> <li>Reviewing and approving project field procedures that involve the handling of radioactive materials or access to radiological areas</li> <li>Conducting radiation incident investigations</li> <li>Conducting radiological project inspections</li> <li>Evaluating and selecting a qualified off-site laboratory</li> <li>Coordinating with analytical laboratory and data validator to assure proper implementation of SAP requirements</li> <li>Reviewing off-site laboratory data against requirements in this SAP prior to use</li> <li>Assessing off-site data to ensure that the quality of the data meets the intended use of the data</li> </ul>
Erik Abkemeier	PRSO	Tetra Tech	<ul style="list-style-type: none"> <li>Overseeing overall radiological operations</li> <li>Ensuring that all radiological operations are performed in accordance with Tetra Tech's Nuclear Regulatory Commission (NRC) Materials License #29-31396-01, as amended</li> </ul>
Tom Johnston	QAM	Tetra Tech	<ul style="list-style-type: none"> <li>Establishing and maintaining the QA program</li> <li>Acting as a focal point for coordination for quality matters concerning project analysis</li> <li>Suspending project activities if quality standards are not maintained</li> <li>Interfacing with the Navy, including RASO, on quality-related items</li> <li>Performing reviews of audit and surveillance reports conducted by others</li> <li>Implementing Navy technical direction letters related to quality topics</li> <li>Verifying that data collection methods specified in the SAP comply with Navy and Tetra Tech requirements</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
TBD	SS	Millennium	<ul style="list-style-type: none"> <li>• Providing day-to-day technical and administrative oversight of radiological operations</li> <li>• Reviewing scan and static survey data prior to it being sent to the RE</li> <li>• Ensuring that all radiological instrumentation is functioning properly</li> <li>• Performing sampling activities as directed by the management plan, SAP, and TSPs</li> <li>• Ensuring that field supplies are available on site</li> <li>• Identify Issues in the field that result in changes in scope</li> <li>• Provide applicable training to Survey Team members</li> <li>• Maintain project documentation</li> <li>• Assign sample numbers (along with RE) as sample locations are identified</li> <li>• Responsible for the care and custody of collected samples</li> <li>• Generates weekly status reports</li> <li>• Generates Field Task Modification Requests, as required</li> <li>• Performs field sampling system audits</li> </ul>
Dick Dubiel	RE	Millennium	<ul style="list-style-type: none"> <li>• Implementing the management plan, SAP, and TSPs</li> <li>• Ensuring that field personnel have documented training on survey and sampling procedures for specific project requirements</li> <li>• Assisting HP in review of off-site laboratory data against requirements in this SAP prior to use</li> <li>• Identification and implementation of field and analytical corrective actions and verification of corrective action effectiveness</li> <li>• Assists SS in conducting field sampling system audits</li> <li>• Assisting SS in assigning field sample numbers</li> <li>• Reviews field and laboratory data to assess quality control</li> </ul>
Lawson Bailey	SSO	Tetra Tech	<ul style="list-style-type: none"> <li>• Oversees site safety</li> <li>• Implements requirements of HASP and all applicable OSHA workplace safety standards</li> <li>• Responsible for implementing appropriate site control measures and personal protection levels</li> <li>• Conducts safety briefings for site personnel and site visitors</li> <li>• Can suspend operations that threaten health and safety</li> </ul>

## SAP WORKSHEET #7 – PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name	Title/Role	Organizational Affiliation	Responsibilities
Heather Shaffer	Laboratory PM	GEL	<ul style="list-style-type: none"> <li>Reviewing laboratory sample results</li> <li>Implementing laboratory SOPs</li> <li>Overseeing performance of gamma spectroscopy, strontium 90 (Sr-90), Tritium (H-3) and alpha spectroscopy analyses</li> <li>Ensuring that all laboratory instrumentation is properly maintained and calibrated, as necessary</li> <li>Reviewing gamma spectroscopy analytical result reports to ensure that the MDCs are below the release criteria, that the counting uncertainties are within tolerance of the reported activity, and that the flags associated with each report represent a clear understanding of the associated reported activity for the isotope in question</li> <li>Verifying each analytical result by reviewing the spectrum file associated with each report</li> <li>Ensuring that the electronic and hard copies of the analytical summary reports are delivered to the contractor for review</li> </ul>
Joe Samchuck	Data Validator	Tetra Tech	<ul style="list-style-type: none"> <li>Perform independent data validation of all laboratory generated data.</li> </ul>

Notes:

BRAC Base Realignment and Closure  
 EPM Environmental Project Manager  
 FTMR Field Task Modification Request  
 HASP Health and Safety Plan  
 MDC Minimum Detectable Concentration  
 NRC Nuclear Regulatory Commission  
 OSHA Occupational Safety and Health Administration  
 PHP Project Health Physicist  
 PM Project Manager  
 PMO Project Management Office  
 PRSO Project Radiation Safety Officer

QA Quality Assurance  
 QAM Quality Assurance Manager  
 RASO Radiological Affairs Support Office  
 RE Radiological Engineer  
 ROC Radionuclide of Concern  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager  
 SAP Sampling and Analysis Plan  
 SOP Standard Operating Procedure  
 SS Site Supervisor  
 TSP Task Specific Plan

**SAP WORKSHEET #8 – SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE**  
 (UFP-QAPP Manual Section 2.4.4)

Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates <sup>1</sup>
Radiation Awareness Training	SS	TBD	Survey Team/Subcontractors	SS, RE and SSO will be responsible for the field training	Documentation of special training requirements will be maintained at the site by the SS
Surface contamination monitor (SCM) Operations	SS		Survey Team		
Portable and Fixed Instrument Training	SS		Survey Team		
Radiological Sampling	SS		Survey Team		
Project SOPs	SS		Survey Team		

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response (HAZWOPER) training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 (e). Project-specific safety requirements are addressed in greater detail in the site-specific HASP.

CFR Code of Federal Regulations  
 HASP Health and Safety Plan  
 OSHA Occupational Safety and Health Administration  
 RE Radiological Engineer

SCM Surface Contamination Monitor  
 SOP Standard Operating Procedure  
 SS Site Supervisor  
 SSO Site Safety Officer

## SAP WORKSHEET #9 – PROJECT SCOPING SESSION PARTICIPANTS SHEET

(UFP-QAPP Manual Section 2.5.1)

<b>Project Name:</b> Basewide Radiological Surveys <b>Projected Date(s) of Sampling:</b> TBD <b>Project Manager:</b> Lawson Bailey, Tetra Tech		<b>Site Name:</b> NAS JRB Willow Grove <b>Site Location:</b> Willow Grove, Pennsylvania		
<b>Date of Session:</b> 2/15/13 <b>Scoping Session Purpose:</b> Discussion of Former NAS JRB Willow Grove Radiological Program				
Name	Title/Role	Affiliation	Phone No.	E-mail Address
Willington Lin	BRAC Environmental Coordinator	BRAC PMO E	215-897-4904	<a href="mailto:willie.lin@navy.mil">willie.lin@navy.mil</a>
Todd Bober	Navy RPM	BRAC PMO NE	215-897-4911	<a href="mailto:todd.bober@navy.mil">todd.bober@navy.mil</a>
Steve Doremus	Director, EP Programs	RASO	757-887-7745	<a href="mailto:steve.doremus@navy.mil">steve.doremus@navy.mil</a>
Laurie Lowman	Lead Environmental Program Manager	RASO	757-887-7650	<a href="mailto:laurie.lowman@navy.mil">laurie.lowman@navy.mil</a>
Patrick Owens	Environmental Program Manager	RASO	757-887-7644	<a href="mailto:patrick.a.owens@navy.mil">patrick.a.owens@navy.mil</a>
Lawson Bailey	PM/PHP	Tetra Tech	803-641-6326	<a href="mailto:lawson.bailey@tetrattech.com">lawson.bailey@tetrattech.com</a>
Amy Stanford	Health Physicist	Tetra Tech	803-641-6328	<a href="mailto:amy.stanford@tetrattech.com">amy.stanford@tetrattech.com</a>
Garth Glenn	Dep. Program manager	Tetra Tech	757-461-3926	<a href="mailto:garth.glenn@tetrattech.com">garth.glenn@tetrattech.com</a>

Comments/Decisions: General approach to scoping surveys of outdoor areas. Outstanding items required for initiating building surveys. Initial discussion of survey requirements and field implementation were discussed.

Notes:

BRAC Base Realignment and Closure  
 NE Northeast  
 PHP Project Health Physicist  
 PM Project Manager

PMO Program Management Office  
 RASO Radiological Affairs Support Office  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager

## **SAP WORKSHEET #10 – PROBLEM DEFINITION**

(UFP-QAPP Manual Section 2.5.2)

### **10.1 SITE DESCRIPTION**

The U.S Navy property known as NAS JRB Willow Grove consists of approximately 1,100 acres in southeastern Pennsylvania. The Main Station is located in Horsham Township and lies in the east-central portion of Montgomery County, immediately adjacent to Bucks County. The Main Station is located on gently rolling terrain with elevations ranging from 240 feet above mean sea level (AMSL) to 360 feet AMSL. The Main Station is bounded by State Route 611 toward the east, Horsham Road to the southwest, Keith Valley Road to the north, and County Line Road to the northeast. Entrance to the Station is gained through the main gate located on State Route 611.

NAS JRB Willow Grove includes a Main Station and two remote housing areas, the Shenandoah Woods and Jacksonville Road Housing areas. The Shenandoah Woods Housing Area is approximately 4.5 miles east of the Main Station and encompasses 51 acres in Warminster Township, Bucks County, Pennsylvania. The Jacksonville Road Housing Area is located in the Borough of Ivyland, Bucks County, Pennsylvania. It encompasses 2.5 acres and is approximately 3.5 miles east of the Main Station. The housing areas are not part of this plan.

The original land consisting of NAS JRB Willow Grove was acquired by the Navy in 1942 from Harold Pitcairn and was formally commissioned NAS Willow Grove in July 1943. In 1957, the Navy purchased additional land bordering the Station to bring the total land area of the Station to approximately 1,100 acres. In 1994, the Station's name was changed to Naval Air Station Joint Reserve Base, Willow Grove, to more accurately reflect the mission of the Station, which at that time supported the Navy, Marine Corps, and Air Force, Army Reserve and Pennsylvania Air National Guard.

Details of the radiological history of NAS JRB Willow Grove are provided in Section 6.0 of the HRA ([Tetra Tech 2012](#)). Historical radiological operations relevant to activities proposed for this project included the following:

- Overhaul and repair of aircraft instruments containing radium-226 (Ra-226) painted components;
- Maintenance, and storage of - depleted uranium (mostly uranium-238 [U-238]) counterweights;
- Use and storage of electron tubes that contained cobalt 60 (Co-60) and thorium 232 (Th-232);
- Use and storage of self-illuminating signs and aircraft lights that contained tritium (H-3);

## **SAP WORKSHEET #10 – PROBLEM DEFINITION (CONTINUED)**

- Use and storage of aircraft detector probes, pressure indicators, helicopter blade inspection systems, and personnel markers that contained and strontium 90 (Sr-90);
- Use and storage of spark-gap irradiators that contained cesium 137 (Cs-137), uranium oxide (UO<sub>2</sub>), or Co-60;
- Use and storage of night vision devices, turret assemblies, and aircraft gear boxes that contained Th-232.
- Disposal of Ra-226 contaminated liquids via the storm and sanitary drain system; and
- Disposal of radioactive material (all isotopes) in landfills; such as IRP Sites 1, 3 and 12.

### **10.2 PROBLEM DEFINITION**

#### **STEP 1: State the Problem**

The HRA ([Tetra Tech 2012](#)) has identified the potential presence of radionuclides exceeding unrestricted radiological release criteria for building surfaces, outdoor surfaces and soils, materials, and equipment at numerous sites at NAS JRB Willow Grove. A complete list of the areas included in this SAP is listed on Table 10-1 below. Buildings within the scope of this SAP have been categorized as Class 1, 2 or 3, using the definitions found in Multi-Agency Radiological Survey and Site Investigation Manual (MARSSIM) guidelines (Nuclear Regulatory Commission [[NRC](#)] 2000), based on the potential for residual contamination as determined in the HRA ([Tetra Tech 2012](#)).

## SAP WORKSHEET #10 – PROBLEM DEFINITION (CONTINUED)

**TABLE 10-1: POTENTIALLY IMPACTED SITES AND INVESTIGATION PARAMETERS**

Site	Sub Site	Contaminant(s)	Media	HRA Recommendation	Former Uses
4	Footprint of demolished building – 1,680 m <sup>2</sup>	Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Training Instruction Building
18	Footprint of demolished building – 266 m <sup>2</sup>	Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Operations and Control Tower
20	Footprint of demolished building – 1,535 m <sup>2</sup>	Sr-90, Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Old Aircraft Repair Hangar, Parachute and Survival Equipment Shop, AIMD, Avionics
22	Original structure and '70s addition – 1,579 m <sup>2</sup>	Sr-90, Ra-226	Structure, Fixtures and Concrete Slab	Scoping survey of impacted rooms	Aircraft Supply Warehouse
23	Footprint of demolished building – 1,535 m <sup>2</sup>	Sr-90, Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Parachute Shop
29	Interior of Building – 1,839 m <sup>2</sup>	Sr-90, Ra-226	Structure, Fixtures and Concrete Slab	Scoping survey of building	Aviation Supply and Station Weapons Building
77	Footprint of demolished building – 1,363 m <sup>2</sup>	Sr-90, Ra-226	Ground surface, surface soil	Scoping survey of building footprint	Supply Dept., AIMD Paraloft
80	Interior of Hangar – 3,344 m <sup>2</sup> North Lean To – 641 m <sup>2</sup> South Lean To – 203 m <sup>2</sup>	H3, Sr-90, Ra-226, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	AIMD Maintenance Hangar
118	Shop and Storage Rooms – 42 m <sup>2</sup>	Sr-90, Ra-226	Structure, Fixtures and Concrete Slab	Scoping survey of building	Ground Electronic Maintenance Division (GEMD)
140	Shops and Labs – 376 m <sup>2</sup>	Ra-226	Structure, Fixtures	Scoping survey of building	ASW Training Facility, Avionics Training
175	Interior of Hangar – 30,359 m <sup>2</sup>	Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	VP Hangar

## SAP WORKSHEET #10 – PROBLEM DEFINITION (CONTINUED)

Site	Sub Site	Contaminant(s)	Media	HRA Recommendation	Former Uses
177	Interior of Hangar – 1,490 m <sup>2</sup>	Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	Army Aviation Support Facility (Hangar)
180	Avionics Shops - 865 m <sup>2</sup>	Sr-90, Ra-226, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	AIMD, Parachute Loft
601	Shops and Labs - 870 m <sup>2</sup>	H-3, Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	AIMD Training Facility
680	Interior of Hangar – 2,676 m <sup>2</sup> Shops - 111 m <sup>2</sup>	Sr-90, U-238	Structure, Fixtures and Concrete Slab	Scoping survey of building	Marine Hangar
Site 1	Footprint of landfill disposal trenches – 8,093 m <sup>2</sup>	Sr-90, Ra-226, U-238	Ground surface, surface soil	Scoping survey of known or suspected disposal areas	Privet Road Landfill
Site 3	Footprint of landfill disposal trenches – 32,421 m <sup>2</sup>	Sr-90, Ra-226, U-238	Ground surface, surface soil	Scoping survey of known or suspected disposal areas	North Street Landfill
Site 12	Footprint of landfill disposal trenches – 44,514 m <sup>2</sup>	Sr-90, Ra-226, U-238	Ground surface, surface soil	Scoping survey of known or suspected disposal areas	South Landfill

[Note: Additional buildings may be added depending on the approval of the Historical Site Assessment.]

Notes:

AIMD Aircraft Intermediate Maintenance Division  
 GEMD Ground Electronics Maintenance Division  
 H-3 Tritium  
 Ra-226 Radium 226

Sr-90 Strontium 90  
 U-238 Uranium 238  
 VP Patrol Squadron

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS**

(UFP-QAPP Manual Section 2.6.1)

### **STEP 2: Identify the Goal of the Study**

The decision at the former NAS JRB Willow Grove is to determine whether concentrations of radioactive materials on building surfaces within the scope of the management plan at NAS JRB Willow Grove exceed the specified release criteria (Table 6-1 of the management plan). If the concentrations of radioactive materials do exceed the specified release criteria, those surfaces or areas must be remediated along with additional surveys taken; otherwise the surfaces or areas may be recommended for free release or surface release with land use restrictions.

### **STEP 3: Identify Information Inputs**

The following physical and radiological data are needed to resolve the problem presented in [Section 10.2](#).

#### **Types of Radiological Testing**

The following types of scanning and static radiological measurement must be performed at each site.

- Walk-over scans
- Static scans
- Soil sampling
- Swipes (alpha, beta and H-3) for surface contamination
- Sediment sampling
- Offsite sample media analysis

#### **Survey and Sample Locations**

##### Reference Background Area

The reference area is a geographical area from which representative radioactivity measurements are performed for comparison with measurements performed in an impacted area. The reference area selected should have physical, chemical, radiological, and biological characteristics similar to the impacted area(s) being investigated. The reference area must not be identified as impacted by the HRA ([Tetra Tech 2012](#)). All on-site and off-site locations selected as reference areas will be approved by the RSO or RSOR. The same survey methods and equipment that will be used for conducting a survey in an impacted area will be used for the background area survey. Reference area data will normally be provided to the RSOR prior to the start of a survey.

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

### Building Surveys

Scanning and static radiological surface measurements must be performed at each site. Location data is dependent upon the method of survey or type of sample. The following records will be generated for each specific method of survey and type of sample.

- Individual computer-generated survey unit maps will be created for each walk-over survey. These maps include every detection for the surveyed area and are designated by x- and y- coordinates within the instrumentation.
- Visual markings on the surface will be created by the operator by the placement of instrumentation. The visual markings will be transcribed to radiation survey maps for every static survey that has a detection of radiation.
- Photographs and hand marked locations on building schematics to designate the location of every sediment sample. Sediment sample locations will be identified in the naming scheme for each laboratory sample generated.

### Land Surface Surveys

Scanning and static radiological surface measurements and soil sampling must be performed at each site. Location data is dependent upon the method of survey or type of sample. The following records will be generated for each specific method of survey and type of sample.

- Individual computer-generated survey unit maps will be created for each walk-over survey. These color coded maps will include gamma readings taken at two second intervals while traversing the survey unit. GPS coordinates will be collected but not reported on the survey map.
- Soil samples locations will be determined using a systematic triangular grid system. Visual markings on the surface will be created by the operator for each soil sampling location.

### **Radioactivity of the Radionuclides of Concern**

Radioactivity of each ROC listed in the HRA ([Tetra Tech 2012](#)) and summarized in Section 1.3. The radioactivity will be determined in accordance to the radiation survey methods discussed in [Worksheet #14](#) and in Section 5.0 of the management plan. In order to determine if the detections exceed unrestricted/free release or limited release criteria the maximum results must be compared to action levels.

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

### **Action Levels**

Action levels provide the point of comparison for determining whether free release or limited release of an area is possible. Action levels for each ROC are specified in Worksheet #15 and Section 6.0 of the management plan. The release criteria for each building of interest are based on the historical use of radioactive material in that building. Specific media action levels are recorded from the following criteria:

- Release criteria for M&E and structures (building surfaces) are based on USAEC *Regulatory Guide 1.86* ([USAEC 1974](#)).
- Release criteria for soils/sediment were derived from NUREG-1757, *Consolidated Decommissioning Guidance* [[NRC 2006a](#)]. NUREG-1757 values were based on not exceeding a dose limit from residual radioactivity of 25 mrem/y. For NAS JRB Willow Grove, the NUREG-1757 values were scaled down so that the dose from residual radioactivity would not exceed 15 mrem/y.

DCGLs (net of material background) shall serve as the action levels. Specific total radioactivity for each ROC is listed in [Worksheet #15](#). For soils and building sediment samples in which multiple radionuclides were used, the release criteria will be the sum of the fractions less than one.

### **Measurement Techniques**

Measurement techniques are described in detail in Section 7.0 of the management plan. The following types of measurements and samples may be utilized as inputs to the decision question.

- Large area gas proportional detector measurements
- Hand-held gas proportional detector measurements
- Scintillation detector measurements
- Geiger Mueller (GM) measurements in drain pipes
- Scintillation detector measurement of swipe samples
- Laboratory alpha, beta, and gamma spectroscopy of samples
- Liquid Scintillation Counting of swipe samples for tritium

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

Section 8.0 of the management plan describes the number and types of measurements included as part of the area surveys.

### **STEP 4: Define the Boundaries of the Study**

Areas or items of interest where data will be collected include building surfaces, sediment in sediment traps and drains and soil that could have been contaminated with radionuclides as a result of site-related operations. The initial boundaries for this survey include buildings and surface areas identified below and in the HRA ([Tetra Tech 2012](#)). The potentially affected media include surface soils, concrete and tile floors, exterior concrete and sheet metal walls, interior sheetrock, wood panel walls, acoustic tile ceilings and sediment on surfaces and in drains. Expansion of the boundaries may occur if contamination is identified at the periphery of an area in such a manner that it would be reasonable to assume the contamination could continue beyond the originally defined boundary (for example, within 6 feet of an established boundary, excluding walls). The specific boundaries for each of the buildings and surface areas are identified in the TSPs for that area. Sediment sampling would only be necessary if the buildings and locations have floor drains with sufficient sediment quantity to produce a representative sample. Spatial boundaries apply for these investigations:

***Building 4 (Footprint): (1,680 square meters [ $m^2$ ])***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 18 (Footprint): (266  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 20 (Footprint): (1,535  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 22: (1,579  $m^2$ )***

A scoping survey will be performed of the building interior as a single Class 3 survey unit.

***Building 23 (Footprint): (1,535  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 29: (1,839  $m^2$ )***

Scoping survey will be performed on the building interior as a single Class 3 survey unit.

***Building 77 (Footprint): (1,363  $m^2$ )***

Scoping survey will be performed of the building footprint as a Class 3 survey unit.

***Building 80 (4,188  $m^2$ )***

Scoping surveys will be performed as four Class 3 survey units in the Hangar proper, five Class 3 survey units in the North Lean To and two Class 3 survey units in the South Lean To.

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

***Building 118: (42 m<sup>2</sup>)***

A scoping survey will be performed of the building interior as two Class 3 survey units.

***Building 140 (376 m<sup>2</sup>)***

Scoping surveys will be performed as seven Class 3 survey units.

***Building 175: (30,035 m<sup>2</sup>)***

Scoping survey will be performed in four Class 3 survey units in the Hangar proper and two Class 3 survey units in the electronic maintenance shops.

***Building 177: (1,490 m<sup>2</sup>)***

Scoping survey will be performed in two Class 3 survey units in the Hangar proper and two Class 3 survey units in the support areas.

***Building 180: (865 m<sup>2</sup>)***

Scoping survey will be performed in four Class 3 survey units.

***Building 601 (870 m<sup>2</sup>)***

Scoping surveys will be performed as ten Class 3 survey units.

***Building 680 (2,787<sup>2</sup>)***

Scoping survey will be performed in three Class 3 survey units in the Hangar proper and three Class 3 survey units in the electronic maintenance shops.

***Site 1 (Landfill Footprint): (8,093 m<sup>2</sup>)***

Scoping survey will be performed of known or suspected disposal areas.

***Site 3 (Landfill Footprint): (32,421 m<sup>2</sup>)***

Scoping survey will be performed of known or suspected disposal areas.

***Site 12 (Landfill Footprint): (44,514 m<sup>2</sup>)***

Scoping survey will be performed of known or suspected disposal areas.

Note: A Class 3 Survey Unit is defined in MARSSIM [NRC 2000] as an area that has been impacted, has little or no potential for delivering a dose above the release criterion and has little or no potential for small areas of elevated activity. There is no limit on the total area of a Class 3 area.

### **STEP 5: Develop the Analytic Approach**

The objective of the management plan and SAP focuses on whether a specific building or land area at NAS JRB Willow Grove has residual radioactivity below levels that will allow for unrestricted/free release. HRA recommendations for a scoping survey must be surveyed as a

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

Class 3 or greater. Characterization survey recommendations must be surveyed as a Class 2 or greater. Areas known to have been previously contaminated must be surveyed as Class 1 areas.

The decision rules applicable to this project are:

- If any background subtracted scan measurement is greater than the DCGL, then take a fixed measurement to confirm the elevated reading, otherwise continue scanning. If an elevated reading is confirmed by a static reading to exceed the release criteria, then classify the unit as having failed the survey and designate it for further investigation.

If the level of background-corrected radioactivity in each sample collected from building surfaces or sediment samples is less than the applicable release criteria (See [Worksheet #15](#)) for a particular site, then recommend no further investigation and a unrestricted/free release of the location, otherwise document the survey/sample location, the extent and level of contamination and recommend that the survey/sample location be designated for possible future remediation.

Note: Background reference area measurements must be performed in non-impacted facilities constructed of similar materials, using similar measurement methods and constructed during the same timeframe as the impacted sites. These reference area measurements will consist of scanning and static surface measurements for comparison to the associated measurements to be performed at the impacted sites. Background reference areas will be identified by the SPM and PHP with the approval of RASO. Additional background reference areas may be required during survey operations if variances in background relative to survey areas are identified.

### **STEP 6: Specify Performance or Acceptance Criteria**

The surveys and sediment sampling will be performed from locations suspected to be, or most likely to be, contaminated by historical operations and from locations intended to bound the lateral extent of contamination. Determining the vertical extent of contamination is only applicable when sediment sampling would be necessary due to the presence of floor drains in buildings. The survey design is based on historical background information and is designed as a graded approach; the consequences of making a decision error are biased toward collecting additional information and taking corrective action to reduce or eliminate contamination levels. Any sampling uncertainty is controlled by the survey design which collects more data in areas with the greatest potential for residual radioactivity exceeding background. Surveying in locations most likely to have contamination is a part of the strategy because only one survey unit must exceed the applicable release criteria for the location not to be issued a free release of the entire location, making this a conservative investigate approach.

Analytical uncertainty is controlled by use of appropriate instruments, methods, techniques, and QC. Direct measurement MDCs for individual radionuclides using specific analytical methods are identified in Section 7.0 of the management plan. The MDC calculation assumes a Type I

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

decision error rate ( $\alpha$ , the probability of deciding a detector response is above background when only background radiation is present) and a Type II decision error rate ( $\beta$ , probability of deciding a detector response is background when radiation is present at levels above background) of 0.05. Specifying values for MDC helps control the level of uncertainty associated with individual analytical results, which helps control decision errors. A discussion of MDC calculations can be found in Section 7.2 of the management plan.

### **STEP 7: Develop the Plan for Obtaining Data**

Measurement locations and techniques have been selected to provide near real-time data during implementation of field activities. These data will be evaluated and used to refine the scope of field activities, as needed, to optimize implementation of the survey design and ensure the data quality objectives (DQO) are met. The completed survey measurement results from this SAP will be used to determine those areas that meet the release criteria defined in Section 6.0 of the management plan. Generic information regarding types of radiation measurements, instrument detection capabilities, selection of quantities and locations of data to be collected, is contained in this SAP and associated management plan. Site-specific operational details and theoretical assumptions will be identified in relevant TSPs. The proposed survey and sampling program is presented in [Worksheet #17](#) and summarized below.

#### Implementation Phase

The survey design is carried out in accordance with the TSPs resulting in the generation of raw data. All surveys will be performed to the level of Final Status Survey (FSS). Areas that exceed the release criteria presented in [Worksheet #15](#) and Table 6-1 of the management plan will be investigated, marked and documented in survey reports to support remediation efforts that would follow if necessary; however, remediation efforts would be outlined in a separate or revised TSP. Following remediation activities, the affected survey unit area will be resurveyed to demonstrate compliance with the release criteria. The types of surveys and the methods used to perform those surveys are presented in Section 4.0 of the management plan. Additionally, QA/QC measurements will generate data and other important information that will be used during the assessment phase for comparison purposes between reference background, radioactivity detections and normal daily checks of the equipment.

#### Assessment Phase

Assessment activities will be completed in accordance with [Worksheets #34](#) thru [#37](#).

## **SAP WORKSHEET #11 – DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS (CONTINUED)**

### Decision-making Phase

A decision is made, in coordination with the stake holders, based on the conclusions drawn from the assessment process. The ultimate objective is to make technically defensible decisions with a specified level of confidence. When determining compliance with Scoping and FSS goals, the survey data are reviewed. Compliance tests are summarized as follows and outlined in the decision rules above:

- Compare the largest measurement with the DCGL (net of material background).
- Compare the average measurement with the DCGL (net of material background).
- If scan measurements are above the DCGL, then a fixed measurement will be taken to confirm the elevated reading. If the elevated reading is confirmed to exceed the release criteria, then the unit would fail.

When multiple nuclides are present, each with an individual DCGL, the most restrictive criteria will be applied unless the specific nuclides and ratios are identified. If the nuclides and ratios are known, the criteria will be assessed in accordance with the methods given in Section 6.0 of the management plan.

## **SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE** (UFP-QAPP Manual Section 2.6.2)

The primary means of data collection for this project will be direct survey using surface contamination monitor (SCM) for structures and direct gamma scanning surveys for outdoor areas. Samples will be obtained for off-site analysis. Soil and sediment samples will be collected in areas required by the TSPs. All samples will be analyzed to determine isotope specific activities. Both biased and unbiased surface soil samples will be collected at the outdoor sites. The number of samples collected at each site will be specified in the TSP. Based on scanning and static measurements, tritium (H-3) swipes will be collected in Buildings 80 and 601. The number and location will be based on MARSSIM protocols described in Sections 4.4 and 5.3.3.1 of the management plan, and at any area exhibiting increased counts on the beta surface scan.

An undetermined number of sediment samples may be collected from floor drains at various sites. These samples will be analyzed off site for ROCs, but the results will only be used for characterization (isotope identification) and will not be subject to the QC and validation criteria established in this SAP. Likewise, an undetermined number of swipe samples will be collected on building surfaces and materials and analyzed on site for gross alpha and beta contamination. These samples are for characterization only and fall outside of the scope of the QC and validation criteria established in this SAP.

The following sections address QC measures for both field surveying and off-site laboratory analysis.

### **12.1 QUALITY CONTROL SAMPLES**

QC samples are collected and analyzed to check sampling and analytical precision, accuracy, and representativeness. Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD).

Field sampling precision is evaluated by analyzing field duplicate samples. Field duplicates will be collected and analyzed at a frequency of 10 percent for soil/sediment samples.

Laboratory analytical precision is evaluated by analyzing laboratory duplicates. The results of the analysis of each duplicate pair will be used to calculate an RPD for evaluating precision.

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the laboratory controls samples (LCS) or blank spikes, and method blanks. LCS or blank spikes are also analyzed at a frequency of 5 percent. The results of the spiked samples are used to calculate the percent recovery (%R) for evaluating accuracy.

## **SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)**

Table 12-1 presents accuracy goals for the investigation based on the percent recovery of matrix spikes. Results that fall outside the accuracy goals will be further evaluated based on the results of other QC samples.

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. Representative data will be obtained for this project through careful selection of sampling locations and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will also be ensured through the consistent application of established field and laboratory procedures. Laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be non-representative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability is exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

### **12.2 FIELD QUALITY CONTROL SAMPLES**

The following section discusses the types of field QC samples that will be collected for this project.

#### **12.2.1 Field Duplicates**

Field duplicate samples are collected at the same time and from the same source and then submitted as separate samples to the laboratory for analysis. For this project, field duplicates will only be collected for soil and sediment samples. Field duplicates for soil/sediment samples will be collected at a rate of 10 percent. Results from the analysis of soil/sediment field duplicates are used to evaluate precision by calculating the RPD.

### **12.3 LABORATORY QUALITY CONTROL SAMPLES**

The types of laboratory QC samples for this project are discussed in the following sections.

## **SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)**

### **12.3.1 Method Blanks**

Method blanks will be prepared at the frequency prescribed in the individual analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method.

### **12.3.2 Matrix Spike and Matrix Spike Duplicates**

Matrix spike/matrix spike duplicates (MS/MSD) are QC check samples that measure matrix-specific method performance for chemical analysis where analyte recovery is performed to evaluate laboratory accuracy. The results of the spiked samples are used to calculate the %R for evaluating accuracy.

### **12.3.3 Laboratory Control Samples**

LCS, or blank spikes, will be analyzed at the frequency prescribed in the analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method. If %R results for the LCS are outside of the established goals, laboratory-specific protocols will be followed to gauge the usability of the data.

### **12.3.4 Control of Field Measurements**

Control of field measurements obtained using static and scanning instrumentation is detailed in Section 7.0 of the management plan. Data quality is controlled in accordance with applicable SOPs. A list of applicable SOPs addressing data quality control is provided in [Worksheet #19](#). In addition, the SOPs are located in Attachment 4 of the management plan. Field equipment sensitivity performance criteria are provided in [Worksheet #22](#).

## SAP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)

**TABLE 12-1: MEASUREMENT PERFORMANCE CRITERIA TABLE – FIELD QC**

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Field Duplicate	Radionuclides (Gamma Spec), Alpha Spectroscopy, Sr-90, and tritium	One per 10 field samples	Precision	≤50% RPD	S&A

Notes:

A	Analytical
DQI	Data Quality Indicators
QC	Quality Control
RPD	Relative Percent Difference
S	Sampling
Sr-90	Strontium 90

**SAP WORKSHEET #13 – SECONDARY DATA CRITERIA AND LIMITATIONS  
TABLE**

(UFP-QAPP Manual Section 2.7)

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
<i>No secondary data used in developing this SAP.</i>				

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS**

(UFP-QAPP Manual Section 2.8.1)

### **14.1 PROJECT DESCRIPTION**

The primary objective of this project is to perform radiological surveys of building surfaces and conduct sampling and analysis of swipe and sediment samples to determine if specified buildings at NAS JRB Willow Grove can be released or if further actions may be necessary. The primary object for outdoor areas is to perform gamma walkover surveys and soil sampling to assess surficial risks from potential residual radioactivity and to assign land use controls if required. The following field activities will be performed:

- TSP preparation
- HASP preparation
- Mobilization/demobilization
- Site specific health and safety training
- Survey equipment QC checks
- Field survey activities (scanning and static measurements, removable contamination measurements)
- Demolition and disposal activities in support of field survey activities (removal of floor tile and mastic)
- Soil sampling
- Sediment sampling
- Waste management activities
- Field QA/QC management tasks
- Field documentation QA/QC and review tasks
- Off-site laboratory analysis of samples for ROCs
- Data validation
- Survey report generation

The majority of the data generated during field activities will be the result of radiological surveys performed on building surfaces and outdoor areas. These surveys will be in the form of scanning and static measurements for alpha and beta contamination for structures or scanning gamma

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS (CONTINUED)**

measurements for outdoor areas. As applicable, swipe samples for removable contamination will be collected and shipped for analysis at an off-site laboratory. The rationale for the survey design is discussed in general in SAP [Worksheet #17](#) and the management plan and in detail in the TSPs.

### **14.2 SURVEY METHODS**

Survey methods will be performed on building surfaces and outdoor areas in accordance with MARSSIM (NRC 2000) guidance. The TSPs identify the types, including both fixed and removable contamination, and extent of surveys that need to be performed, release criteria, survey unit classifications, decision logic for using real-time data to determine if additional/supplemental surveys are needed, and any other activities that might be required to complete the survey tasks. Data generated during field survey activities may be recorded on survey forms provide in SOP RP-OP-02, captured on a data logger, or recorded by laptop computer via a data link.

### **14.3 SOIL AND MEDIA SAMPLING**

Soil and media samples will be collected during field activities for analysis at an off-site laboratory and are identified in SAP [Worksheet #18](#). The number and type(s) of samples will be identified in the TSPs. Sampling will be performed in accordance with SOPs referenced in the worksheet. Additionally, other samples will be collected from various facilities to support evaluation of compliance with release criteria and to determine specific nuclides as necessary. These samples could include swipes or sediment, if found, in floor drains, sink drain openings, and ventilation openings or other concentration points if loose materials are found. All sample locations will be identified on a survey unit map.

### **14.4 ADDITIONAL FIELD ACTIVITIES**

In support of various field survey activities, remediation activities will be required to access potentially impacted surfaces. Loose equipment may consist of office materials such as desks and chairs, or other materials left from base operations. All materials will be surveyed for free release, using Regulatory Guide 1.86 release criteria (U.S. Atomic Energy Commission 1974). Because of the difficulty of performing adequate release surveys on floor tile, removed floor tile will be treated as low level radioactive waste (LLRW) and controlled and stored as such. Since the potential exists for the floor tiles or mastic to contain asbestos, it will also be controlled and labeled in accordance with applicable regulations (10 CFR 20 and 29 CFR 1910).

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS (CONTINUED)**

### **14.5 DATA MANAGEMENT**

This section provides direction for managing the environmental technical data associated with this SAP. Proper organization will ensure that data and documentation fully describe the results of the sampling and analysis activities performed in support of this SAP.

#### **14.5.1 Project Data Logbooks and Forms**

This project will generate project data logbooks and field forms (chain-of-custody [COC] data, maps, photographs, field audit reports) during sampling and data collection activities.

Project data will be recorded in project data logbooks or on approved forms. Multiple survey teams may use individual project data logbooks during the field effort. Sample collection forms, direct measurement forms, and photographic log sheets will be provided as needed to sampling teams in the field. All actions taken to review, approve, transfer, copy, duplicate, backup, store or secure project data will be noted in a project data logbook.

Project data logbooks, individual team member logbooks, field data forms, COC forms, and copies of all electronic data files will be filled out as the activities are performed and collected at completion of fieldwork.

The data will be entered and reviewed for accuracy and completeness by the SPM, RE, or SS. Following review, the SPM, RE, or SS will certify accuracy of information in the project data logbooks. Following completion of the project, the PM will review and verify the project data logbooks for defensibility and accuracy.

Project data will be recorded in a project data logbook or on approved forms. Individual survey teams or instruments may use field data logbooks during the field effort as long as they are assigned to individual survey teams or equipment.

Data logbooks and approved forms are considered legal records. Logbooks will be permanently bound and the pages will be numbered. Pages may not be removed from logbooks under any circumstances. Logbook entries will be legible, factual, detailed, and complete and will be signed and dated by the individuals making the entries. Completed forms will be legible, detailed, factual, and signed and dated by the individual completing the form. If a mistake is made in a log or on a form, placing a single line through the erroneous entry and initialing and dating the correction will denote the error. Under no circumstances will any previously entered information be completely obliterated. Use of whiteout in data logbooks or on forms is not permitted for any reason.

## **SAP WORKSHEET #14 – SUMMARY OF PROJECT TASKS (CONTINUED)**

### **14.5.2 Photographic Records**

Photographs of sample collection and direct measurement activities taken during the field operations will be documented in a project logbook or using approved forms. Electronic photos will be saved as Joint Photographic Experts Group (JPEG) format files. Descriptions of photographs will include the room number; direction photographer is facing, and any measurement location information relevant to the photograph to correlate location. Photographs will only be taken with the approval of the PHP or the SPM.

### **14.5.3 Data Media**

The data media will be physical and electronic in the form of project data logs (physical) and diskette with hard-drive and CD-ROM backup as defined in [Section 14.5.4](#) below.

### **14.5.4 Data Backup and Security Policy**

Project electronic data will be downloaded from its collection device (for example laptop computers and data loggers) on a daily basis. At the conclusion of each day's survey activities, electronic data collected that day will be backed up to appropriate removable media (for example compact disk, zip disk, or equivalent) and the backup will be removed from the site. The backup will not be stored in the same building in which the original project electronic data are stored.

## SAP WORKSHEET #15 – REFERENCE LIMITS AND EVALUATION TABLE

(UFP-QAPP Manual Section 2.8.1)

Radionuclides	CAS Number	SURFACES	SOILS <sup>b</sup>	WATER <sup>d</sup>	Laboratory Specific	
		Structures, M&E, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	pCi/g <sup>c</sup>	pCi/L	QL pCi/g	MDA pCi/g
Radium-226	13982-63-3	100	1.0	5 <sup>e</sup>	0.7	0.33
Strontium-90	10098-97-2	1,000	1.02	8	0.32	0.32
Tritium (H-3)	10028-17-8	5,000	66	20,000	10 pCi/ sample	10 pCi/ sample
Uranium-238	7440-61-1	5,000	8.4	30	0.5	0.5

Notes:

pCi/g picocurie per gram

pCi/L picocuries per liter

dpm disintegration per minute

a These limits are based on AEC Regulatory Guide 1.86 ([USAEC 1974](#)). Values indicate the measured value above background as determined from the reference area. Limits for removable surface activity are 20 percent of these values.

b These limits are based on Nuclear Regulatory Commission document NUREG-1757, Consolidated Decommissioning Guidance ([NRC 2006](#)), whose limits are deemed in compliance with the 25 mrem/y unrestricted dose limit in 10CFR20.1402. Listed values were developed by scaling the NUREG-1757 values to 15 mrem/y unrestricted dose.

c Criteria is above background for those radionuclides found in background soils.

d Release criteria for water have been derived from *Radionuclides Notice of Data Availability Technical Support Document* ([EPA 2000](#)) Table III, which compared the federal drinking water standards from the 1976 and 1991 Maximum Contaminant Levels. This value reflects the most conservative limit.

e Limit is for total Radium Concentration.

**SAP WORKSHEET #16 – PROJECT SCHEDULE / TIMELINE TABLE**  
 (UFP-QAPP Manual Section 2.8.2)

Activities	Organization	Deliverable	
		Anticipated Date of Completion	Version
Prepare and Submit Internal Draft Management plan	Tetra Tech	6/13/12	Internal Draft
Review Internal Draft Management plan	Navy	4/12/12	NA
Revise Internal Draft Management plan	Tetra Tech	10/10/12	Internal Draft
Prepare and Submit Revised Internal Draft Management plan	Tetra Tech	10/10/12	Revised Internal Draft
Review Revised Internal Draft Management plan	Navy	1/14/13	NA
Prepare RTC on Revised Internal Draft Management plan	Tetra Tech	1/31/13	NA
Review RTC on Revised Internal Draft Management plan	Navy	1/31/13	NA
Prepare and Submit Draft Management plan	Tetra Tech	6/14/13	Draft
Draft Management plan Review - Regulators	Agency	TBD	NA
Prepare RTC on Draft Management plan	Tetra Tech	TBD	NA
RTC on Draft Management plan Review- Regulators	Agency	TBD	NA
Prepare and Submit Draft Final Management plan	Tetra Tech	TBD	Draft Final
Draft Final Management plan Concurrence Period	Agency	TBD	NA
Prepare and Submit Final Management plan	Tetra Tech	TBD	Final
Conduct Radiological Surveys	Tetra Tech	TBD	NA

## **SAP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE** (UFP-QAPP Manual Section 3.1.1)

### **17.0 SAMPLING DESIGN AND RATIONALE**

This project involves a radiological survey to support disposition decisions for buildings, outdoor areas and equipment at NAS JRB Willow Grove. These include interior portions of standing buildings and sediment, demolished building footprints and IR Sites. These buildings and outdoor areas have been identified as impacted areas in the HRA, NAS JRB Willow Grove, History of the Use of General Radioactive Materials, 1943-2011 ([Tetra Tech 2012](#)). Activities at these buildings and outdoor areas involving radioactive materials included handling of radioluminescent items (such as aircraft instrument panels), maintenance and storage of DU counterweights, storage and maintenance of aircraft parts with radioactive materials (such as drogue lights) storage and maintenance of weapons, the storage of non-licensed commodity items (such as tritium (H-3) exit signs) and the disposal of potentially radioactive commodities at operating landfills. The management plan and associated TSPs are intended to provide technically sound data and information to determine the status of the facilities relative to an unrestricted release.

The HRA ([Tetra Tech 2012](#)) provides the details regarding where and when radioactive materials were used in each of the buildings. A summary of each of the involved buildings and the means by which they may have been impacted by operations with radioactive materials is included in the TSPs, in conjunction with this management plan. The HRA ([Tetra Tech 2012](#)) defines specific areas within buildings that are impacted and the associated ROCs. The HRA ([Tetra Tech 2012](#)) provides initial classifications in accordance with the MARSSIM ([NRC 2000](#)).

Release criteria for the basewide radiological survey management plan are based on U.S. Atomic Energy Commission (USAEC) Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* ([USAEC 1974](#)), or a concentration that is equivalent to 15 millirem per year (mrem/y) from residual radioactivity. These values were obtained by scaling the values found in Nuclear Regulatory Commission document NUREG-1757, Consolidated Decommissioning Guidance ([NRC 2006](#)), which are based on a 25 mrem/y dose, to 15 mrem/y. The release criteria for materials and equipment are also based on Regulatory Guide 1.86 ([USAEC 1974](#)). Limits for removable surface activity on materials and equipment are 20 percent of the Regulatory Guide 1.86 surface activity limits.

### **17.1 SURVEY REQUIREMENTS**

The survey design requirements for each area classification are presented in the management plan and TSP. Requirements for scan speed, number distribution and count time for direct measurements, and removable contamination surveys are defined. Survey requirements for both alpha emitting and beta emitting radionuclides and for gamma scanning surveys are presented in the management plan and TSP. In some areas, equipment such as tile flooring and mastic are identified for removal to expose those surfaces that have the potential for residual contamination. Survey requirements for the materials and equipment to be removed are presented in the

## **SAP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE (CONTINUED)**

management plan and TSP. An area-by-area listing of the survey requirements is presented in the management plan and TSP.

For each building and outdoor area, the specific survey requirements are detailed in a TSP. The TSPs provide detailed instruction on an area by area basis to the field personnel to ensure that all aspects of the plan are implemented. Collection and management of data generated by the management plan and TSP is detailed to ensure data integrity, that valid analysis can be performed and that data are retrievable at future dates.

### **17.2 SAMPLING METHODS**

Samples will be collected during field activities to support the release of potentially impacted sites and to provide characterization data on facility systems (for example, floor drains and ventilation systems). Media sampling will also be used to characterize materials for waste disposal (for example, asbestos floor tile and mastic). All sampling activities will be conducted in accordance with SOPs.

Surface soil sampling will be performed as required by the TSPs. Samples collected from the potentially impacted area will be analyzed for the ROCs by an off-site laboratory.

Sediment sampling will be performed as required by the TSPs. Samples collected from the potentially impacted area will be analyzed for the ROCs by an off-site laboratory.

Swipe samples will be collected in areas where tritium is listed as an ROC using standard tritium sampling techniques. These samples will be analyzed for tritium by an off-site laboratory. The total number of tritium swipes will be determined based on field screening results.

Additionally, an undetermined number of swipe and sediment samples will be collected for characterization purposes only. These samples could include swipes of material, floor/sink drain openings, ventilation openings, and sediment samples from floor drains. All sample locations will be identified on a survey map. The swipe samples will be analyzed on site for gross alpha and beta activity using a scintillation detector identified in Table 7-1 of the management plan, and the surface soil and sediment samples will be sent to an off-site laboratory for analysis. It is doubtful that adequate sediment sample volume will be recovered from floor drains to allow for a full suite of analyses to be performed, so the priority will be for gamma spectroscopic analysis. The results of the swipe and sediment samples will be qualitative in nature and will be used only for characterization purposes.

## **SAP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE (CONTINUED)**

### **17.3 MANAGEMENT OF INVESTIGATION-DERIVED WASTE**

Investigation-derived waste (IDW) may be generated during field activities. If generated, this material will be stored in 55-gallon drums, B-12 or B-25 boxes, roll-off containers, or intermodal containers. This material will be sampled to characterize for disposal. The samples will be analyzed for ROCs by an off-site laboratory. The results of this analysis will be provided to the radiological waste contractor under the direction of the Navy Low Level Radioactive Waste (LLRW) Disposal Program. These samples will be analyzed for characterization only, and sample results will not be subject to the QC and validation criteria established in this SAP.

### **17.4 MANAGEMENT OF RADIOLOGICAL WASTE**

Radiologically contaminated debris may be generated during remediation activities. This material could consist of floor tiles and mastic and miscellaneous debris.. If unconditional release surveys determine that these items are contaminated above release limits or if a release survey is not possible, then the items will be containerized as described in paragraph 17.3 above. The radiological waste contractor will further characterize the waste and assure appropriate disposal under the direction of the Navy LLRW Disposal Program.

**SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP  
REQUIREMENTS TABLE**  
(UFP-QAPP Manual Section 3.1.1)

**TABLE 18-1: SAMPLING LOCATIONS AND METHOD/SOP REQUIREMENT TABLE**

Sampling Location/ ID Number <sup>1</sup>	Matrix	Depth (ft.)	Analytical Group	Number of Samples <sup>2</sup>	Sampling SOP Reference
Building 80/080-SWI-001 to 187	Swipes (H-3)	Surface	Tritium	187	SOP 009
Building 80/D	Swipes (H-3)	Surface	Tritium	19 duplicates	SOP 009
Building 601/601-SWI-001 to 170	Swipes (H-3)	Surface	Tritium	170	SOP 009
Building 601/D	Swipes (H-3)	Surface	Tritium	17 duplicates	SOP 009
Building 4/004-SOI-TBD	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 4/D	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 18/018-SOI-TBD	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 18/D	Soil	0 – 0.5	Ra-226	TBD	SOP 009
Building 20/020-SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 20/D	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 22/022-SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 22/D	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 23/023-SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 23/D	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 29/029-SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 29/D	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 77/077-SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 77/D	Soil	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 80/080-SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
Building 80/D	Sediment	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009

## SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Sampling Location/ ID Number <sup>1</sup>	Matrix	Depth (ft.)	Analytical Group	Number of Samples <sup>2</sup>	Sampling SOP Reference
Building 118/118- SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 118/D	Sediment	0 – 0.5	Ra-226, Sr-90	TBD	SOP 009
Building 140/140- SED-TBD	Sediment	0 – 0.5	Ra-226	TBD	SOP 009
Building 140/D	Sediment	0 – 0.5	Ra-226	TBD	SOP 009
Building 175/175- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 175/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 177/177- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 177/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 180/180- SED-TBD	Sediment	0 – 0.5	Ra-226, Sr-90, U- 238	TBD	SOP 009
Building 180/D	Sediment	0 – 0.5	Ra-226, Sr-90, U- 238	TBD	SOP 009
Building 601/601- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 601/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 680/680- SED-TBD	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
Building 680/D	Sediment	0 – 0.5	Sr-90, U-238	TBD	SOP 009
IR Site 1/IR1-SOI- TBD	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 1/D	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 3/IR3-SOI- TBD	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 3/D	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009

## SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Sampling Location/ ID Number <sup>1</sup>	Matrix	Depth (ft.)	Analytical Group	Number of Samples	Sampling SOP Reference
IR Site 12/IR12- SOI-TBD	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009
IR Site 12/D	Soil	0 – 0.5	Ra-226, Sr-90, U-238	TBD	SOP 009

Notes:

- 1 Sediment samples from drains in the various buildings will be collected, if available, as described in the management plan and TSP. Swipe samples will be collected as directed by the TSP. All sample locations will be logged and mapped.
- 2 The number of surface soil samples collected at the outdoor sites will be specified in the TSP.

D	Duplicate
H-3	Tritium
ID	Identification
N/A	Not applicable
Ra-226	Radium 226
SOP	Standard operating procedure
Sr-90	Strontium 90
TBD	To be determined
U-238	Uranium 238

### Sample Numbering

Field samples will be numbered using a numbering system listing the building (or location), the sample type, and a sequential numbering system (for example 200-SED-0001). The first position indicates the building or location. The following table matches the identifier with the correct building or location.

004 = Building 4	140 = Building 140
018 = Building 18	175 = Building 175
020 = Building 20	177 = Building 177
022 = Building 22	180 = Building 180
023 = Building 23	601 = Building 601
029 = Building 29	680 = Building 680
077 = Building 77	IR1 = IR Site 1
080 = Building 80	IR3 = IR Site 1
118 = Building 118	IR12 = IR Site 12

The second position corresponds to the sample type; where “SOI” is a soil sample, “SED” is a sediment sample, “COR” is a core sample, and “SWI” is a swipe sample. The identifier “001” corresponds to a sequential number. All samples will be logged in the sample logbook.

## **SAP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)**

**TABLE 18-2: SURFACE CONTAMINATION MONITOR OPERATIONS PROCEDURES (ATTACHMENT 4)**

<b>Procedure</b>	<b>Title</b>	<b>Rev</b>
SCM-OPS-01	Position Sensitive Proportional Counters Purging	0
SCM-OPS-02	Position Sensitive Proportional Counters Plateau Determination	0
SCM-OPS-03	Position Sensitive Proportional Counters Position Calibration	1
SCM-OPS-04	Encoder Calibration	0
SCM-OPS-05	Position Sensitive Proportional Counters Efficiency Calibration	0
SCM-OPS-06	Position Sensitive Proportional Counters Quality Assurance	1
SCM-SETUP-01	Position Sensitive Proportional Counters Repair	0
SCM-SETUP-02	Hardware Setup	0
SCM-SETUP-03	Quality Assurance Testing of Surface Contamination Monitor	0

## SAP WORKSHEET #19 – ANALYTICAL SOP REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

**TABLE 19-1: ANALYTICAL SOP REQUIREMENTS TABLE**

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference	Containers (number, size, and type)	Sample volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Soil/Sediment/Solids	Radionuclides <sup>1</sup> (Gamma Spectroscopy)	EPA Method 901.1 or equivalent / GL-RAD-A-013 R25	500-mL plastic container	At least 500 grams	Not applicable	N/A
Soil/Sediment/Solids	Radionuclides (Isotopic Uranium)	A-01-R MOD / GL-RAD-A-011 R23	500-mL plastic container	At least 500 grams	Not applicable	N/A
Soil/Sediment/Solids	Radionuclides (Sr-90)	EPA Method 905 MOD / GL-RAD-A-004 R16	500-mL plastic container	At least 500 grams	Not applicable	N/A
Swipes	Tritium (H-3)	EPA Method 906.0 MOD / GL-RAD-A-002 R21	250 mL glass vial with screw-on cap	1 swipe per vial	Not applicable	6 months

<sup>1</sup> The laboratory will report the "long list" gamma emitting isotopes

EPA U.S. Environmental Protection Agency  
 H-3 Tritium  
 mL Milliliter

N/A Not Applicable  
 SOP Standard Operating Procedure  
 Sr-90 Strontium 90

**TABLE 19-2: TESTAMERICA LABORATORY PROCEDURES**

Procedure	Title	Rev
GL-RAD-I-001	Gamma Spectroscopy	19
GL-RAD-I-009	Alpha Spectroscopy	14
GL-RAD-I-004, GL-RAD-I-014 & GL-RAD-I-017	Liquid Scintillation	17 14 11
GL-RAD-I-006 & GL-RAD-I-016	Low Background Gas Flow Proportional Counting (GFPC) System	14 7

**SAP WORKSHEET #20 – FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE**  
(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	No. of Sampling Locations <sup>1</sup>	No. of Field Duplicates	Total No. of Samples to Lab
Swipes	Tritium	357	36	393
Surface Soils	Gamma Spec, Alpha Spec, GFPC	TBD	TBD	TBD

Alpha Spec	Alpha Spectroscopy
Gamma Spec	Gamma Spectroscopy
GFPC	Gas Flow Proportional Counting
H-3	Tritium
TBD	To be determined

**SAP WORKSHEET #21 – PROJECT SAMPLING SOP REFERENCES TABLE**  
(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 006	Radiation and Contamination Surveys, Rev. 0	Tetra Tech	GM, Gas Flow proportional and/or Scintillation Detectors. Cloth and Massilin-type swipes	No	None
SOP 008	Air Sampling and Sample Analysis, Rev.0	Tetra Tech	Low-volume, high-volume and lapel air samplers	No	None
SOP 009	Sampling Procedures for Radiological Surveys, Rev. 0	Tetra Tech	Hand Auger, Split Spoon Sampler or Equivalent. Trowel or equivalent flat surface instrument	No	None

Notes:

GM                      Geiger-Mueller

**SAP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE,  
TESTING, AND INSPECTION TABLE**  
(UFP-QAPP Manual Section 3.1.2.4)

Calibration and quality control procedures for field instrumentation will be performed to ensure instruments are operating properly and produce data that satisfy the project objectives. Routine calibration and standardization will be performed prior to use and verified during use to ensure that instruments are operating properly and are producing accurate and reliable data. Instruments will be calibrated by an approved vendor in accordance with American National Standards Institute (ANSI) N323, American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments (ANSI 1997), at a frequency recommended by the manufacturer. At a minimum, calibrations of radiation detection instruments will be performed annually and after repair. Field instrument checks, using National Institute of Standards and Technology (NIST) traceable sources, will verify instrument response, and will typically be performed at the beginning and end of each day, at a minimum. If the instrument checks reveal that the instrument is outside established accuracy limits, the instrument will be marked out of service. If necessary, the instrument will be returned to the manufacturer for immediate repair and servicing.

Control of field measurements obtained using static and scanning instrumentation is detailed in Section 7.0 of the management plan. Data quality is controlled in accordance with applicable SOPs.

## SAP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE (CONTINUED)

Measurement/ Technique	Type of Instrument		Calibration Frequency <sup>1</sup>	Response Check <sup>2</sup>	Acceptance Criteria <sup>3</sup>	Corrective Action
	Detector	Meter Description				
Surface Alpha Scan	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Surface Alpha Scan	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Surface Beta Scan	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Surface Beta Scan	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Static Alpha Measurement	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Static Alpha Measurement	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 Hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Static Beta Measurement	Gas Proportional Ludlum 43-68	Ludlum 2221, or data logger 2350-1, 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Static Beta Measurement	Position Sensitive Proportional Counter	Surface Contamination Monitor	Annual	Every 4 Hours	1 of 3 > 3 $\sigma$ or 2 of 3 > 2 $\sigma$	Remove from service
Static Beta Measurement	Geiger-Mueller Model 44-9	Ratemeter 3	Annual	Daily	$\pm$ 20%	Remove from service
Swipe Analyzer	Ludlum 43-10-1 Scintillation Probe	Ludlum Model 2929	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service
Gamma Scans	Ludlum 44-10	Ludlum Model 2241 or 2360	Annual	Daily	> 2 $\sigma$ then retest; if repeat > 2 $\sigma$ fail	Remove from service

**SAP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE  
(CONTINUED)**

Measurement/ Technique	Type of Instrument		Calibration Frequency <sup>1</sup>	Response Check <sup>2</sup>	Acceptance Criteria <sup>3</sup>	Corrective Action
	Detector	Meter Description				
Gamma Exposure Rate	Micro R meter Ludlum Model 19	Sodium Iodide	Annual	Daily	± 20%	Remove from service

<sup>1</sup> Gas Proportional Counters and Scintillation Counters will have the efficiency of each instrument established using a NIST traceable source prior to use in this project and annually or following instrument repair that affects the performance characteristics.

<sup>2</sup> Response checks are not required for instruments not in use.

<sup>3</sup> The listed acceptance criterion for the PSPC is for performance based checks. A daily source check is also performed with an acceptance criterion of ± 20%.

## SAP WORKSHEET #23 – ANALYTICAL SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.2.1)

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
GL-RAD-A-013	Gamma Spec Analysis, R25	Definitive	Soil & Sediment / Gamma	HPGe	GEL Laboratories, LLC Charleston, SC	No
GL-RAD-A-004	Sr-90 Analysis, R16	Definitive	Soil & Sediment / Sr-90	GFPC	GEL Laboratories, LLC Charleston, SC	No
GL-RAD-A-011	Alpha Spectroscopy Analysis, R23	Definitive	Soil & Sediment / Iso-U	Alpha Spectrometer	GEL Laboratories, LLC Charleston, SC	No
GL-RAD-A-011	Liquid Scintillation Counter Analysis, R21	Definitive	Swipes / H-3	Liquid Scintillation Counter	GEL Laboratories, LLC Charleston, SC	No

### Notes:

GFPC      Gas Flow Proportional Counter  
 H-3      Tritium  
 HPGe      High Purity Germanium  
 Iso-U      Isotopic Uranium  
 SOP      Standard Operating Procedure  
 Sr-90      Strontium 90

## SAP WORKSHEET #24 – ANALYTICAL INSTRUMENT CALIBRATION TABLE

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA <sup>1</sup>	SOP Reference <sup>2</sup>
Alpha Spectroscopy	ICAL	Monthly	Energy: each isotope $\pm 40$ keV of expected Energy: Slope $\leq 15$ keV/channel Efficiency: Fixed Point	Repeat initial calibration	Laboratory Analyst	GL-RAD-I-009
	CCV	Daily Pulser	Within "Boundary" parameters	Repeat CCV once; repeat ICAL if second CCV fails	Laboratory Analyst	GL-RAD-I-009
HPGe Gamma Spectroscopy System	ICAL	Yearly	Energy within 0.1keV FWHM $\leq 3.0$ keV at 1332 keV Efficiency $\leq 8\%$	Repeat initial calibration	Laboratory Analyst	GL-RAD-I-001
	ICV	After ICAL	Efficiency $\leq 10\%$	Repeat ICV once; repeat ICAL if second ICV fails	Laboratory Analyst	GL-RAD-I-001
	CCV	Daily	Control chart mean $\pm 3 \sigma$	Repeat CCAL once; flag detector out of service for day if second CCAL fails	Laboratory Analyst	GL-RAD-I-001

## SAP WORKSHEET #24 – ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA <sup>1</sup>	SOP Reference <sup>2</sup>
Low Background Gas Flow Proportional Counting (GFPC) System	ICAL	Yearly	Individual Points $\pm 10\%$	Evaluation for possible repeat initial calibration	Laboratory Analyst	GL-RAD-I-006, GL-RAD-I-016
	ICV	After ICAL	Recovery $\pm 25\%$	Repeat ICV once; repeat ICAL if second ICV fails	Laboratory Analyst	GL-RAD-I-006, GL-RAD-I-016
	CCV	Daily	Control chart mean $\pm 3\sigma$	Repeat CCAL once; flag detector out of service for day if second CCAL fails	Laboratory Analyst	GL-RAD-I-006, GL-RAD-I-016
Liquid Scintillation Counting	ICAL	Yearly	Quench curve, 1000 counts per data point	Recalibration	Laboratory Analyst	GL-RAD-I-004, GL-RAD-I-014, GL-RAD-I-017
	ICV	After ICAL	Second Source check standard at quench curve - all $\pm 10\%$ of known value	Re-prep / reanalysis of ICV and/or ICAL	Laboratory Analyst	GL-RAD-I-004, GL-RAD-I-014, GL-RAD-I-017

Notes:

- 1 Name or title of responsible person may be used
- 2 Specify the appropriate reference letter or number from the Analytical SOP References table ([Worksheet #23](#)).

CA Corrective action  
 CCAL Continuing calibration  
 CCV Continuous calibration verification  
 FWHM Full width at half maximum  
 ICAL Initial calibration

ICV Initial calibration verification  
 keV Kilo electron volt  
 $\sigma$  Sigma  
 % Percent

**SAP WORKSHEET #25 – ANALYTICAL INSTRUMENT AND EQUIPMENT  
MAINTENANCE, TESTING, AND INSPECTION TABLE**  
(UFP-QAPP Manual Section 3.2.3)

Analytical instrument and equipment maintenance, testing and inspection is performed in accordance with the GEL Quality Assurance Plan, GL-QS-B-001 R26. Maintenance, testing and inspections requirements are contained in the laboratory SOPs listed in [Worksheet # 23](#).

**SAP WORKSHEET #26 – SAMPLE HANDLING SYSTEM**  
(UFP-QAPP Manual Appendix A)

<b>SAMPLE COLLECTION, PACKAGING, AND SHIPMENT</b>
Sample Collection (Personnel/Organization): Survey Technician/MSI
Sample Packaging (Personnel/Organization): Survey Technician/ MSI
Coordination of Shipment (Personnel/Organization): Site Supervisor/MSI
Type of Shipment/Carrier: Exempted Quantity/Federal Express
<b>SAMPLE RECEIPT AND ANALYSIS</b>
Sample Receipt (Personnel/Organization): Lab Technician/GEL
Sample Custody and Storage (Personnel/Organization): Lab Technician/ GEL
Sample Preparation (Personnel/Organization): Lab Technician/ GEL
Sample Determinative Analysis (Personnel/Organization): Lab Technician/ GEL
<b>SAMPLE ARCHIVING</b>
Field Sample Storage (No. of days from sample collection): See <a href="#">Worksheet #19</a>
Sample Extract/Digestate Storage (No. of days from extraction/digestion): See <a href="#">Worksheet #19</a>
Biological Sample Storage (No. of days from sample collection): Not applicable
<b>SAMPLE DISPOSAL</b>
Personnel/Organization: GEL

Notes:

MSI      Millennium Services, Inc.

## **SAP WORKSHEET #27 – SAMPLE CUSTODY REQUIREMENTS TABLE** (UFP-QAPP Manual Section 3.3.3)

### **27.1 SAMPLE IDENTIFICATION**

Unique sample identification numbers for field and field QA/QC samples will be assigned by the RE or SS as sample locations are identified in accordance with the numbering convention described in [Worksheet #18](#).

### **27.2 SAMPLE COLLECTION DOCUMENTATION**

Documentation of field observations will be recorded in project data logbooks and field forms, including sample collection forms, direct measurement forms, survey records and photographic log sheets. Field logbooks utilized on this project will consist of a bound, page numbered logbook. All pages of the logbooks will be numbered sequentially and observations will be recorded with indelible ink.

Field sample collection forms will be used to document sample collection details, and other observations and activities will be recorded in the project data logbook.

For sampling and field activities, the following types of information will be recorded in the project data logbooks or forms as appropriate:

- Site name and location
- Date and time of sample activities
- Personnel and their affiliations
- Weather conditions (if applicable)
- Activities involved with the sampling
- Subcontractor activity summary
- Site observations including site entry and exit times
- Site sketches made on site
- Visitor names, affiliations, arrival and departure times
- Health and safety issues including personal protective equipment (PPE)

## **SAP WORKSHEET #27 – SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)**

### **27.3 SAMPLE HANDLING AND TRACKING SYSTEM**

These subsections outline the procedures that will be used by field and laboratory personnel to document project activities and sample collection procedures during field survey activities. All forms must be filled in as completely as possible.

#### **27.3.1 Sample Handling**

Sample handling is described in [Worksheet #26](#). Samples will be collected and processed in accordance with applicable radiological SOPs.

#### **27.3.2 Sample Delivery**

Samples to be delivered to the laboratory will be made by FedEx. After samples have been collected, they will typically be sent to the laboratory within 24 hours.

#### **27.3.3 Sample Custody**

To ensure the integrity of a sample from collection through analysis, it is necessary to have an accurate, written record that traces the possession and handling of the sample. This documentation is referred to as the COC form. The chain of custody begins at the time of sample collection.

A sample is under custody if:

- The sample is in the physical possession of an authorized person
- The sample is in view of an authorized person after being in his/her possession
- The sample is placed in a secure area by an authorized person after being in his/her possession
- The sample is in a secure area, restricted to authorized personnel only

Custody documentation is designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. A multi-part form is used with each page of the form signed and dated by the recipient of a sample or portion of sample. The person releasing the sample and the person receiving the sample each will retain a copy of the form each time a sample transfer occurs.

## **SAP WORKSHEET #27 – SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)**

Integrity of the samples collected during the site investigation will be the responsibility of identified persons from the time the samples are collected until the samples, or their derived data, are incorporated into the final report.

The SS is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the COC form. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (FedEx Corporation). Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs identified in [Worksheet #23](#).

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE

(UFP-QAPP Manual Section 3.4)

<b>Matrix</b>	Soil					
<b>Analytical Group</b>	Radionuclides (Gamma spec)					
<b>Analytical Method / SOP Reference</b>	EPA Method 901.1 / GL-RAD-A-013 R25					
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less.	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less.

Notes:

MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE (CONTINUED)

<b>Matrix</b>	Soil					
<b>Analytical Group</b>	Radionuclides (Isotopic Uranium)					
<b>Analytical Method / SOP Reference</b>	A-01-R-Mod MOD (modified for soil)/ GL-RAD-A-011 R23					
<b>QC Sample</b>	<b>Frequency / Number</b>	<b>Method / SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>Data Quality Indicator (DQI)</b>	<b>Measurement Performance Criteria</b>
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limits 20% or less.	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less.

Notes:

MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE (CONTINUED)

<b>Matrix</b>	Soil					
<b>Analytical Group</b>	Radionuclides (Sr-90/Total Sr) <sup>a</sup>					
<b>Analytical Method / SOP Reference</b>	EPA Method 905 MOD / GL-RAD-A-004 R16					
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limits 20% or less	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less

<sup>a</sup> Samples will be analyzed for total Sr. If the total Sr value exceeds the release criteria (Worksheet 15), the sample will be analyzed for Sr-90.

Notes:

MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference  
 Sr Strontium  
 Sr-90 Strontium 90

## SAP WORKSHEET #28 – LABORATORY QC SAMPLES TABLE (CONTINUED)

<b>Matrix</b>	Soil					
<b>Analytical Group</b>	Tritium (H-3)					
<b>Analytical Method / SOP Reference</b>	EPA Method 906.0 MOD / GL-RAD-A-002 R 21					
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	Results less than the laboratory reporting limit	Narrate/Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Contamination	No target compounds >RL
LCS	One per preparation batch	75-125% Recovery	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias	75-125% Recovery
Laboratory duplicates	One per preparation batch	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less	Recount/Reanalyze batch	Laboratory Analyst	Accuracy/Bias - Precision	If activity is <5*MDC, then RPD limit is 100% or less. If activity is >5*MDC, then RPD limit is 20% or less

Notes:

H-3 Tritium  
 MDC Minimum Detectable Concentration  
 RL Reporting Limit  
 RPD Relative Percent Difference

## SAP WORKSHEET #29 – PROJECT DOCUMENTS AND RECORDS TABLE

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
<b><u>Sample Collection Documents and Records</u></b> Field logbook (and sampling notes) Field sample forms (boring logs, sample log sheets, drilling logs) Chain of custody records Sample shipment air bills Equipment calibration logs Photographs Sampling and Analysis Plan Field Sampling SOPs	Millennium Project file (Original records will be maintained by SS on site with back-up copies stored at an off-site location)
<b><u>Laboratory Documents and Records</u></b> Sample receipt/login form Sample storage records Sample preparation logs Standard traceability logs Equipment Calibration logs Sample analysis run logs Equipment maintenance, testing , and inspection logs Corrective action forms Reported field sample results Reported results for standards, quality control checks, and quality control samples Data completeness checklists Sample storage and disposal records Telephone logs Extraction/clean-up records Raw data	GEL Project file (Project file copy will subsequently be sent to NAVFAC MIDLANT Administrative Record)
<b><u>Data Assessment Documents and Records</u></b> Field Sampling Audit Checklist (if an audit is conducted) Analytical Audit Checklist (if an audit is conducted)	Tetra Tech Project file (Original records will be maintained by PM on site with back-up copies stored at an off-site location)
Data Validation Report	Tetra Tech Project file (Project file copy will subsequently be sent to NAVFAC MIDLANT Administrative Record)

Project-Specific SAP  
Naval Air Station Joint Reserve Base Willow Grove  
Willow Grove, Pennsylvania

Title: Basewide Radiological Surveys  
Revision Number: NA  
Revision Date: NA

## **SAP WORKSHEET #29 – PROJECT DOCUMENTS AND RECORDS TABLE (CONTINUED)**

Notes:

NAVFAC MIDLANT Naval Facilities Engineering Command Mid-Atlantic  
PM Project Manager  
SOP Standard Operating Procedure  
SS Shift Supervisor

## SAP WORKSHEET #30 – ANALYTICAL SERVICES TABLE

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization
Soil Sediment Solids	Gamma emitting isotopes	All	EPA Method 901.1	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566
Soil Sediment Solids	Total Sr	All	EPA Method 905	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566
Soil Sediment Solids	Alpha emitting isotopes	All	A-01-R	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566
Swipes	H-3	All	EPA Method 906	28 Days	GEL Laboratories, LLC Contact: Heather Shaffer P.O. Box 30712 Charleston, SC 29417 843-556-8171	TestAmerica Laboratories, Inc., St. Louis Contact: Erika Starman 13715 Rider Trail North Earth City, MO 314-298-8566

Notes:

Labs are Pennsylvania certified and Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) approved.

EPA U.S. Environmental Protection Agency  
 H-3 Tritium

ID Identification  
 Sr Strontium

## **SAP WORKSHEET #30 – ANALYTICAL SERVICES TABLE (CONTINUED)**

### **30.1 LABORATORY QUALIFICATION**

Laboratories that support the Navy directly or through subcontracts are evaluated and approved for Navy use by the Naval Facilities Engineering Service Center (NFESC). Laboratories that support Tetra Tech under Navy contracts have been selected from the list of laboratories approved by NFESC and evaluated by Tetra Tech to assure that the laboratory can meet the technical requirements of the laboratory SOW and produce data of acceptable quality.

### **30.2 DATA DELIVERABLES**

The subcontracted laboratory will provide electronic data deliverable (EDD) for all analytical results generated for the field samples collected for off-site analysis. An automated laboratory information management system must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. EDDs will be compatible with the Navy electronic data deliverable (NEDD) format. Results that should be included in all EDDs are as follows:

- Target analyte results for each sample and associated analytical methods requested on the chain-of-custody form
- Method and instrument blanks and preparation and calibration blank results reported for the sample delivery group (SDG)
- Percent recoveries for the spike compounds in the MS, MSDs, blank spikes, or LCSs
- Matrix duplicate results reported for the SDG
- All re-analysis, re-extractions, or dilutions reported for the SDG, including any associated with samples and the specified laboratory QC samples

Electronic data must be retained for a minimum of 10 years after final data have been submitted. The subcontractor laboratory will use an electronic storage device capable of recording data for long-term, off-line storage. Raw data will be retained on an electronic data archival system.

Data will be reported in tabular format to be included in the report. The electronic data in NEDD format will be submitted to the Naval Installation Restoration Information Solution (NIRIS) database within 30 days of completion of validation, as described in EWI EVR.6, Environmental Data Management and Required Electronic Delivery Standards ([NFESCSW 2005](#)).

**SAP WORKSHEET #31 – PLANNED PROJECT ASSESSMENTS TABLE**  
(UFP-QAPP Manual Section 4.1.1)

<b>Assessment Type</b>	<b>Frequency</b>	<b>Internal or External</b>	<b>Organization Performing Assessment</b>	<b>Person(s) Responsible for Performing Assessment</b> (title and organizational affiliation)	<b>Person(s) Responsible for Responding to Assessment Findings</b> (title and organizational affiliation)	<b>Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)</b> (title and organizational affiliation)	<b>Person(s) Responsible for Monitoring Effectiveness of CA</b> (title and organizational affiliation)
Laboratory Systems Audit	Every 18 months to 2 years	External	DoD ELAP	Laboratory QA	Laboratory QA	Laboratory QA	Laboratory QA

Notes:

DoD            Department of Defense  
ELAP        Environmental Laboratory Accreditation Program  
QA            Quality Assurance

**SAP WORKSHEET #32 – ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES**  
(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Laboratory systems audit	Written audit report	TBD/Laboratory Lab QA, NFESC	Not specified by NFESC	Letter	Laboratory PM/QA, NFESC	Specified by NFESC

Notes:

NFESC	Naval Facilities Engineering Service Center
PM	Project Manager
QA	Quality Assurance
TBD	To Be Determined

## SAP WORKSHEET #33 – QA MANAGEMENT REPORTS TABLE

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data validation report	Weekly	Beginning of business, following week	SPM	Navy RPM, RASO
Major analysis problem identification (Internal Memorandum)	When persistent analysis problems are detected	Immediately	SPM or designee	Navy RPM, RASO
Project monthly progress report	Monthly for duration of the project	Monthly	SPM	Navy RPM, RASO
Field status reports	Weekly, oral, during the course of sampling	Weekly during field activities	SS	Navy RPM, RASO
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately	Lab QA	Navy RPM, RASO, PHP

Notes:

PHP Project Health Physicist  
 QA Quality Assurance  
 RASO Radiological Affairs Support Office  
 RPM Remedial Project Manager  
 SPM Subcontract Project Manager  
 SS Site Supervisor

**SAP WORKSHEET #34 – VERIFICATION (STEP I) PROCESS TABLE**  
(UFP-QAPP Manual Section 5.2.1)

Verification Input	Description	Internal (I) / External (E)	Responsible for Verification (name, organization)
Field Logbook	Field logbooks will be reviewed weekly and verified that the information is complete in accordance with requirements in <a href="#">Section 14.5</a> of this SAP.	I	SPM or designee, Millennium
COC Forms	COC forms will be reviewed against shipping container contents. The COC will be signed and the original will be shipped to the laboratory within the cooler. The copy will be kept in project files.	I	SPM or designee, Millennium
Sample acknowledgement	The sample acknowledgment generated by the laboratory will be reviewed against the COC for accuracy and for potential analytical issues.	E	Laboratory custodian, TBD
Laboratory Data Package	Prior to submittal to Tetra Tech, the laboratory will review the laboratory data and associated pages for completeness and technical readiness.	E	Laboratory technician, TBD
Laboratory data package/electronic data	The laboratory data and electronic data will be reviewed by Tetra Tech to confirm all sample analyses requested have been provided and that all of the required information for validation has been included in the data package. Tetra Tech will also compare the electronic data to the hard copy report for consistency.	I	SPM PHP/ Tetra Tech
Field and Electronic Data	One hundred percent of manual entries will be reviewed against the hard-copy information. 100 percent of the output from data processing will be validated in accordance with SOP and TSP requirements.	I	SPM or designee, Millennium

Notes:

COC Chain of Custody  
PHP Project Health Physicist  
SAP Sampling and Analysis Plan

SOP Standard Operating Procedure  
SPM Subcontract Project Manager  
TSP Task Specific Plan

## SAP WORKSHEET #35 – VALIDATION (STEPS IIA AND IIB) PROCESS TABLE

(UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)(Worksheet #37)

Step Ila / Iib <sup>1</sup>	Validation Input	Description	Responsible for Validation (name, organization)
Ila	SOPs, SAP	Examine field logbooks and COC forms to ensure sample collection was performed per the plan. Determine impacts of any deviations of sample collection.	SPM or designee, Millennium
Ila	COC Forms	Examine COC forms against SAP requirements such as analytical methods, sample identification, etc.	SPM or designee, Millennium
Iib	Laboratory Data packages	Examine laboratory package against SAP requirements and COC forms (sample identification, holding times, quality control samples, field duplicates, analytical methods, reporting limits, etc.).	Laboratory QA, TBD
Iib	Laboratory Data packages	Determine impacts of any deviations or quality issues associated with analytical data.	Laboratory QA, TBD
Iib	Data validation reports	Determine impacts of any deviations or quality issues associated with analytical data.	PHP/ Tetra Tech

Notes: 90% of the data packages will receive cursory validation and 10% of the data packages will receive full validation.

1 Ila=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]  
Iib=comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

COC Chain of Custody  
PHP Project Health Physicist  
SAP Sampling and Analysis Plan  
SPM Subcontract Project Manager  
TBD To Be Determined

**SAP WORKSHEET #36 –ANALYTICAL DATA VALIDATION (STEPS IIA AND IIB)**  
**SUMMARY TABLE**  
(UFP-QAPP Manual Section 5.2.2.1)(Worksheet #37)

Step Ila / I Ib	Matrix	Analytical Group	Validation Criteria <sup>1,2</sup>	Data Validator
Ila and I Ib	Soil Sediment Solids	Gamma Emitting Isotopes	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA
Ila and I Ib	Soil Sediment Solids	Total Sr	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA
Ila and I Ib	Soil Sediment Solids	Alpha Emitting Isotopes	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA
Ila and I Ib	Swipes	Tritium (H-3)	Worksheets #19, #23, #24, #25, #28 & #29	Laboratory QA

Notes: 90% of the data packages will receive cursory validation and 10% of the data packages will receive full validation.

- 1 All laboratory data will be validated in accordance with the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) [NUREG-1576]. The data validation strategy will be consistent with Navy guidelines. Data validation will also take into consideration the measurement criteria specified in this SAP. See Worksheet #37 for description of validation qualification flags.
- 2 Data validation SOPs can be found in Attachment 3 of the management plan.

H-3 Tritium  
QA Quality Assurance  
Sr Strontium

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT**

(UFP-QAPP Manual Section 5.2.3)

### **37.1 RECONCILIATION WITH USER REQUIREMENTS**

After environmental data have been reviewed, verified, and validated in accordance with the procedures, the data must be further evaluated to determine whether DQOs have been met.

To the extent possible, Tetra Tech will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's "Guidance for Data Quality Assessment, Practical Methods for Data Analysis" (EPA 2000a). The DQA process includes five steps: (1) review the DQOs and sampling design; (2) conduct a preliminary data review; (3) select a statistical test; (4) verify the assumptions of the statistical test; and (5) draw conclusions from the data.

Tetra Tech will systematically assess data quality and data usability when the five-step DQA process is not completely followed because the DQOs are qualitative. This assessment will include the following:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives
- A review of project-specific data quality indicators for precision, accuracy, representativeness, completeness, and comparability (PARCC) and quantitation limits to evaluate whether acceptance criteria have been met
- A review of project-specific DQOs to determine whether they have been achieved by the data collected
- An evaluation of any limitations associated with the decisions to be made based on the data collected.

The final report for the project will discuss any potential impacts of these reviews on data usability and will clearly define any limitations associated with the data.

### **37.2 MEASUREMENT QUALITY OBJECTIVES**

All analytical results will be evaluated during data validation in accordance with PARCC parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the project objectives. The data validation process was described in greater detail in [Worksheet #36](#).

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)**

The following subsections describe each of the PARCC parameters and how they will be assessed within this project.

### **37.2.1 Precision**

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision are evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a RPD:

$$RPD = \frac{|A - B|}{(A + B)/2} \times 100$$

Where:

- A = First duplicate concentration  
B = Second duplicate concentration

Field sampling precision is evaluated by analyzing field duplicate samples.

Laboratory analytical precision is evaluated by comparing analytical results of field samples with those of field duplicates, laboratory matrix duplicates, or by analyzing MS of field samples along with MSD. For this project, MS/MSD samples will be generated for all organic analytes. MS/MSDs or matrix duplicates will be used to assess precision for inorganic analytes. The results of the analysis of each MS/MSD or duplicate pair will be used to calculate an RPD for evaluating precision. [Worksheet #28](#) presents the precision goals for this project.

### **37.2.2 Accuracy**

Field accuracy will be assessed by collecting and analyzing equipment rinsate and source water blank QC samples. These QC samples will be used to evaluate the potential for target analytes to enter samples as a result of sampling processes.

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, LCS or blank spikes, surrogate standards, and method blanks. MS samples will be prepared and analyzed at a frequency of 5 percent for samples that will require analysis for inorganic chemicals. LCS or blank spikes are also analyzed at a frequency of 5 percent or per extraction batch, whichever is most frequent. Surrogate standards, where available, are added to every sample analyzed for organic constituents. The results of the spiked samples are used to calculate the percent recovery (%R) for evaluating accuracy.

## SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)

$$\text{Percent Recovery} = \frac{S - C}{T} \times 100$$

Where:

S = Measured spike sample concentration  
C = Sample concentration  
T = True or actual concentration of the spike

[Worksheet #28](#) presents accuracy goals for this investigation based on the percent recovery of laboratory, matrix, and surrogate spikes. Results that fall outside the accuracy goals will be evaluated further on the basis of the results of other QC samples.

### 37.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will also be ensured through consistent application of established field and laboratory procedures. Laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be nonrepresentative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

For this project the representativeness of samples will be evaluated in part by judging whether samples a sufficient number and type of samples have been collected from locations that are most likely to have been contaminated. This judgment will be applied during sampling by the samplers and the SPM.

### 37.2.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)**

As discussed further in [Section 37.2](#), completeness will also be evaluated as part of the data quality assessment process ([EPA 2000a](#)). This evaluation will help determine whether any limitations are associated with the decisions to be made based on the data collected.

### **37.2.5 Comparability**

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data. Field procedures will be standardized to ensure comparability. The comparability of laboratory data will be assured by use of established and approved analytical methods, consistency in the basis of analysis (wet weight, volume, or similar units), and consistency in reporting units (parts per million, parts per billion, and so forth).

### **37.2.6 Sensitivity - Detection and Quantitation Limits**

The minimum detectable activity (MDA) is the smallest level of radioactivity in a sample that can be reliably distinguished from ambient background. The quantitation limit represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a specific sample matrix. QLs are laboratory-specific quantitation limits for specific analytical methods and sample matrices, such as soil or water, and are typically several times higher than the MDL to allow for matrix effects. PALs, which are established by Tetra Tech in the scope of work for subcontract laboratories, are set to establish minimum criteria for laboratory performance; actual laboratory quantitation limits may be substantially lower.

Analytical methods have been selected for this project so that the QL for each target analyte is below the QL wherever practical. [Worksheet #15](#) compares the PALs for the selected analytical methods with QLs. The QLs listed reflect the maximum sensitivity of current, routinely used analytical methods. All analytes will be reported as estimated values if concentrations are less than PQLs but greater than MDAs. This procedure is being adopted to help ensure that analytical results can effectively be compared with comparison criteria for certain compounds where the screening criteria are near or below the PAL. This procedure also will help to ensure that subsequent statistical evaluations of the data will not be biased by high-value nondetect results.

#### **Minimum Detectable Activity (MDA)**

The minimum detectable activity (MDA) is defined as the smallest level of radioactivity in a sample that can be detected with a 5% probability of erroneously detecting radioactivity, when in fact none was present (Type I error) and also, a 5% probability of not detecting radioactivity, when in fact it is present (Type II error). MDA is often used interchangeably with minimum detectable concentration (MDC), since the difference between the two terms is only one of unit

## SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)

conversion. MDA/MDC is a function of ambient background radiation and counting time. MDA/MDC can be calculated using the following equation:

$$MDA (MDC) = \frac{3 + 3.29 \sqrt{R_b t_b \left(\frac{t_s}{t_b}\right)}}{(eff)(t_s)}$$

Where:

MDA (MDC) = Minimum Detectable Activity (Minimum Detectable Concentration)

$R_b$  = background counting rate

$t_b$  = background counting time

$t_s$  = sample counting time

eff = instrument efficiency

### 37.2.7 Data Usability

Although some qualifiers may be added to the data, a final review of the data set against the EPA data quality parameters will be used to determine if data meet all the requirements of the precision, accuracy, representativeness, completeness, and comparability described in EPA guidance for quality assurance project plans ([EPA 2002](#)), the DoD QSM, and this SAP.

EPA “Risk Assessment Guidance for Superfund” (RAGS) will be used to evaluate the usability of the validated data ([EPA 1989](#)). Chapter 5, Exhibit 5-5 in RAGS states that data qualified as estimated (J) based on data validation reports should be used in quantitative risk assessments. Although this guidance is specifically for human health risk assessments, the same usability criteria will be applied for all the data. Only data qualified as rejected (R) are considered unusable for risk assessment. Accordingly, all J-qualified data, but no R-qualified data, will be used for this investigation.

After completion of the data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and the proportion of samples with detected and non-detected results. The project team members identified by the Tetra Tech PM will assess whether the data collectively support the attainment of project objectives. They will consider whether any missing or rejected data have compromised the ability to make decisions or to make the decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated by other data. Although rejected data will generally not be used, there may be reason to use them in a

## **SAP WORKSHEET #37 – USABILITY ASSESSMENT (CONTINUED)**

weight of evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

### **Data Validation Qualifiers**

Assignment of data qualification flags will conform to EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (2008) and Inorganic Data Review (2004). Data validation specifications require that various data qualifiers be assigned when a deficiency is detected or when a result is less than its detection limit. If no qualifier is assigned to a result that has been validated, the data user is assured that no technical deficiencies were identified during validation. The qualification flags used are defined as follows:

- U – Indicates that the chemical was not detected at the numerical detection limit (sample-specific detection limit) noted. Non-detected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.
- UJ – Indicates that the chemical was not detected; however, the detection limit (sample-specific detection limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.
- J – Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of the concentration that is actually present in the sample. The laboratory reported concentration is considered to be an estimate of the true concentration.
- R – Indicates that the chemical may or may not be present. The non-detected analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (for example, a holding time missed by a factor of two times the specified time limit, severe calibration non-compliance, or extremely low analyte recovery in QC spike samples).

The results of data validation will be presented in a quality control summary report (QCSR). The QCSR section will be included in all versions of the Final Status Survey Report. If, during data validation, non-conformances are identified, the project health physicist will immediately notify the Tetra Tech Project Manager and QAM, and the Navy RPM.

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**ATTACHMENT 4**

**PROJECT STANDARD OPERATING PROCEDURES**

**Standard Operating Procedure**  
**ISSUE AND USE OF RADIATION WORK PERMITS**

**SOP 002**

**Revision 0**

Prepared By:

Lauson Bailey  
Project Health Physicist

3/16/2012

Date

Approved By:

Eric J. Alkensis  
Project Radiation Safety Officer

3/16/2012

Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2010	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

This procedure describes the circumstances when a Radiation Work Permit (RWP) is required and addresses the requirements for planning, developing, issuing, using, modifying and terminating RWPs. The RWP provides a complete document addressing existing radiological conditions, work scope, radiological limitations, specific protective requirements, as low as reasonably achievable (ALARA) considerations and instructions to radiological support personnel. Adherence to this procedure will provide reasonable assurance that personnel exposures will be below specified limits, personnel will remain free of contamination, and contamination will not be spread beyond the designated contaminated area.

## 2.0 SCOPE

This procedure shall be implemented to initiate an RWP for the following jobs:

1. Personnel entry into a contaminated or potentially contaminated area (CA).
2. Personnel entry into a radiation area (RA).
3. Personnel entry into a radiologically controlled area (RCA).
3. Personnel entry into an area where air concentrations could exceed 10 percent of the derived air concentration (DAC).
4. At the discretion of the Site Supervisor (SS).

This procedure describes the radiological surveys required to generate an RWP and provides guidelines to specific protective measures required based upon the radiological conditions in the work area.

In addition to RWPs written to cover specific work tasks, general RWPs may be created to cover non-workers site wide or in more specific sub-areas or buildings. General RWPs do not have the requirements for an Access Log (Attachment 2).

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure.

**Site Project Manager** - The Site Project Manager (SPM) is responsible for implementation and compliance with this Standard Operating Procedure (SOP) during project operations and providing safety briefings to personnel working with radioactive materials. The SPM or designee shall be on site during radiological work. The SPM or designee will conduct periodic reviews, via personal observation of activities carried out under RWPs and other job-specific guidance, to ensure adherence to the requirements of these documents. In instances where the RWP or job-specific guidance documents are not being followed, the SPM or designee shall stop the work.

The SPM or designee shall review and approve RWPs generated by this procedure and ensure that RWPs generated per this procedure are maintained in project files.

**Site Supervisor** - The Site Supervisor (SS) or designee shall be on site during radiological operations. The SS is responsible for the assignment of personnel that will perform the tasks required by this SOP, for the implementation and monitoring of on-site radiological training, control of radioactive material, dosimetry coverage of radiological support personnel, and to ensure that personnel under their cognizance observe proper precautions. The SS is responsible for ensuring that RWPs are properly prepared and completed as required.

**Radiological Control Technician** - The Radiological Control Technician (RCT) shall be responsible for the performance of the requirements of this SOP and documentation of work performed, including interpretation and verification of data. The RCT shall ensure compliance with this and any other referenced procedure. RCTs may assist in training responsibilities as needed. The RCTs shall be aware of changing radiological conditions, which may require different levels of personal protective equipment or respiratory protection and be responsible for enforcing the provisions of the RWP and ALARA philosophy.

**Radiological Support Personnel** - Radiological support personnel are equipment operators and laborers performing field activities in support of survey activities, as defined in Section 3.2.14 of the Base-wide Plan. Radiological support personnel are required to read, understand, sign, and comply with the provisions of the RWP.

**Site Safety Officer** – For purposes of this procedure, the Site Safety Officer (SSO) shall be responsible for reviewing draft RWPs to ensure that relevant non-radiological concerns are addressed.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Airborne Radioactivity Area (ARA)** - A room, enclosure or area in which radioactive material is dispersed in the air in the form of dusts, fumes, particulates, mists, vapors or gases and where the concentration of the dispersed radioactive materials is in excess of:

- The derived air concentrations (DACs) specified in Table 1, Column 3 of Appendix B, Title 10 Part 20 of CFR.
- Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI).

**Contaminated Area (CA)** - Any area where removable surface contamination levels exceed 20 percent of the contamination limits provided in Attachment 1 (Table 1).

**Non-Workers (CA)** - Any persons entering an area covered by a work specific RWP or a general RWP whose sole purpose is only for observation or other tasks, not directly related to the work outlined in the RWP. Individuals that are escorted inside an area covered by a job-specific RWP are exempt from the requirements of this procedure. Non-Workers are also not required to log in and out on Radiation Work Permit Access Logs.

**Radiation Area (RA)** - Any area accessible to personnel in which there exists ionizing radiation at exposure rates such that an individual could receive a deep dose equivalent (DDE) in excess of 2 millirem (mrem) in 1 hour at 30 centimeters (cm) from the radiation source or from any surface that the radiation penetrates.

**Radiologically Controlled Area (RCA)** – An area containing radioactive materials (in excess of the levels provided in Table 1 of Standard Operating Procedure SOP 010, *Radiologically Controlled Areas – Posting and Access Control*) to which access is controlled to protect individuals from exposure to contamination and ionizing radiation.

**Total Effective Dose Equivalent (TEDE)** - TEDE is the sum of the DDE (external dose) and the committed effective dose equivalent (internal dose).

## **6.0 PROCEDURE DETAILS**

### **6.1 GENERAL**

#### **6.1.1 CRITERIA FOR INITIATING RADIATION WORK PERMIT**

An RWP is required when entering radiologically impacted areas (i.e., RCAs, RMAs, radiation areas, contaminated areas, airborne radioactivity areas, underground RMAs).

#### **6.1.2 PLANNING AND PREREQUISITES**

##### **6.1.2.1 Planning the RWP**

The SS or designee initiates the RWP process by filling in the General Information section of the RWP. The accepted form to use for an RWP is included as Attachment 4 of this document. The SPM, or designee, enters the effective date (date the RWP was initiated) and the expiration date that will correspond to the estimated completion date for the project.

The SPM or SS completes the Task section of the RWP. This includes an estimate of the number of personnel required for each task and the number of personnel-hours that will be spent inside a RCA. A detailed description is encouraged but not required and can be attached to the RWP. Work performed in areas with different radiological conditions should be listed as different tasks. This may not become apparent until after the surveys performed to support preparing the RWP are completed.

The SPM, or designee, and the SS:

- Obtain and review any previous surveys performed in the work area.
- Obtain all information available on the identity, form and quantities of radionuclides present in the work area.
- Review facility drawings, if available, to determine ventilation flows, component and equipment layouts and building structures, which can be used for contamination barriers.

The SPM, or designee evaluates the nature of the work to be performed, the specific components or equipment to be worked on, the positions the personnel may take to perform the work, the possibility of releasing radioactive contamination during the work activities, and the potential for changing radiation exposure rates as work progresses.

The SPM, or designee, selects the necessary instrumentation, equipment and protective clothing to perform surveys in the work area. If contamination is expected in the work area, equipment to be taken into the work area may be wrapped to prevent contamination of equipment.

If anticipated contamination levels are above the limits given in Table 1 (Attachment 1) for classification of an area as a contaminated area, contamination controls will be established before entry into the area to prevent the spread of contamination upon exiting.

#### 6.1.2.2 The RWP Pre-job Survey

Safety hazards that may be encountered during the work are evaluated (confined space entry, electric equipment or mechanical equipment requiring lock-out tags, falling objects, bumping hazards, slippery surfaces, fire hazards, etc.). An analysis of each hazard and precautions to be taken shall be documented and provided to personnel prior to entry into the area.

The RCT obtains radiation exposure rates in the area where the personnel will be positioned during work activities. The adjacent area is surveyed to identify any locations where elevated readings are observed and a route to the work area is established. Readings are recorded on survey forms as specified in procedure SOP 006, *Radiation and Contamination Surveys*.

Swipe samples are obtained from the work area, adjacent areas and along the route to the work area in sufficient quantity to adequately design work controls to maintain exposures ALARA. RCTs will rely on their professional experience or consultation with the SS, or designee, to determine what constitutes "sufficient quantity." Swipe samples and air samples collected in the area are then processed and recorded on survey forms, as specified in procedure SOP 006, *Radiation and Contamination Surveys*.

The issuance of an RWP for work in an ARA will require air sampling to be done as part of the RWP. Air sampling is conducted in accordance with SOP 008, *Air Sampling and Sample Analysis*.

An individual assigned by the SS (i.e., the RCT who surveyed the work area and obtained information from prior surveys, when available) records the exposure rates measured during the survey of work area on survey forms as specified in procedure SOP 006, *Radiation and Contamination Surveys*.

## **6.2 PROCEDURE PROCESS**

### **6.2.1 SPECIFYING WORKER AND WORKSITE REQUIREMENTS**

Based on and the data obtained from the pre-job survey and factoring in anticipated contamination conditions in the area, the RCT determines the quantities to specify in Radiological Limits section of the RWP. Limits should be specified as an order of magnitude bound (i.e., whole-body exposure < 10 mrem/hour) that would not be expected to be exceeded under normal working conditions. Space is provided for clarifying remarks or other specific points of note. The radiological limits will govern the work to be done under the RWP. If, at any point during the work, the limits are known to be exceeded, then work must cease and the RWP must be modified or a new RWP must be issued to reflect the current radiological conditions. A well-selected limit will be one general enough to avoid unnecessary stoppages of work while still protecting worker safety per the ALARA philosophy.

Next, the RCT determines the types of protective clothing required to be used by personnel performing prescribed tasks, the respiratory protection requirements, dosimetry requirements, and monitoring requirements and indicates them under the protection requirements section of the RWP. Finally, any additional training requirements for personnel and the need for ALARA briefings or reviews are noted on the RWP.

Determinations of protection requirements are to be performed by the RCT using their professional judgment and in accordance with industry standard practices and appropriate regulatory guidelines. Air monitoring is required if it is likely that airborne contamination may be present or created (i.e., during excavation and demolition) during work activities. Work activities will be stopped if the concentrations of airborne contaminants exceed 10 percent of the DAC.

### **6.2.2 SPECIAL INSTRUCTIONS**

Special instructions associated with personal protective clothing, dosimetry, monitoring and inspection, respiratory protection, training or ALARA are indicated in this section of the RWP.

### **6.2.3 REVIEW AND APPROVALS**

The SS and SSO, or designees, as a minimum, shall approve the RWP prior to work. The SS shall review the sections of the draft RWP completed by the RCT for completeness and accuracy. The SSO shall verify that relevant non-radiological safety considerations are addressed. When the non-radiological concerns of the SSO have

been adequately addressed, the SS will approve the RWP and forward to the SPM, or designee, for review and approval.

RASO shall be notified if any of the following atypical worksite conditions are anticipated:

- An individual TEDE exceeding 500 mrem
- The collective TEDE for the job exceeding 1 rem
- Individual airborne exposures exceeding 10 DAC-hours in a 7-day period
- General area exposure rates exceeding 2 mrem/hour
- Contamination levels exceeding 10 times the limits requiring classification of an area as a CA.

In cases where RASO must be notified, the SPM, or designee, with concurrence from RASO, must approve the RWP prior to work.

The check boxes in the approval section will be marked to indicate which of the approvers is required for each particular RWP. Any mandatory approver may prescribe changes to the draft RWP prior to final approval.

#### **6.2.4 USING THE RADIATION WORK PERMIT**

A pre-job briefing is held with the individuals performing the work described in the RWP. The following topics are discussed in the pre-job briefing:

- Complete descriptions of the work tasks to be performed and method to minimize exposures to radiation and contamination while performing these work tasks.
- Discussions of the radiation, contamination, and airborne radioactive materials in the work area and situations, which could result in increased levels of these components.
- Health and safety concerns, which could be encountered during work activities.
- Emergency procedures and responsibilities.
- Discussions of the protective equipment requirements and the monitoring requirements.

The RCT compiles the current year dose for the individuals performing RWP work to verify that the radiation exposure received during the work activities will not result in the individuals' dose exceeding the administrative limits specified in the Radiological

Control Plan. The individuals' current radiation exposures will be listed on Radiation Work Permit Authorization Log (Attachment 3).

Each individual entering the RWP work area is required to understand the RWP and sign the Radiation Work Permit Authorization Log, indicating that the individual understands the provisions of the RWP, is aware of his/her current year dose, and will comply with the RWP requirements.

An RWP that covers work to be performed at a field site or in a building shall have an Access Log (Attachment 2) appended to the RWP. RWPs that cover general work areas are not required to have an access log, but an access log may be appended to the RWP if desired.

In cases where an Access Log is used, the RCT (or individual) logs the time the individual entered the work area, along with the reading on the individuals Pocket Ion Chamber (PIC) or Direct Reading Dosimeter (DRD), if worn. The RCT (or individual) also indicates if the individual wore a respirator during the work activities. It should be noted that non-workers, as defined in Section 5.0, are not required to sign the Access Log.

When an individual who signed in on a Radiation Work Permit Access Log exits the work area, the RCT (or individual) logs the time the individual leaves the area and the individual's DRD reading, if worn. If the individual returns to the work area, another signature entry (and corresponding line entries) must be made on the Radiation Work Permit Access Log.

As previously noted, if the radiological limits listed on the RWP are exceeded at any point during a prescribed work task, then all work shall be stopped until the RWP can be modified to address the over-limit condition, or a new RWP is issued.

### **6.2.5 MODIFYING THE RADIATION WORK PERMIT**

In the event of changes to the conditions or scope of the work that do not justify the generation of a new RWP, modifications to the RWP may be made by the SS, or designee with concurrence of the SPM. No more than two modifications can be made to an RWP before a new RWP must be issued. Modifications to the RWPs will be reviewed and approved in accordance with the initial requirements, as specified in Section 6.2.3.

To modify the RWP, each change is made with a single line cross out of the text or item. The SS or designee must initial and date adjacent to each change.

The SS or designee must communicate all changes to the individuals working under the RWP.

#### **6.2.6 TERMINATING THE RADIATION WORK PERMIT**

The RWP is terminated when the end date of the RWP is reached or can be terminated by one of the following reasons:

- The job has been completed.
- There is a significant change in the scope of work.
- There is a significant change in the radiological conditions.
- The RWP is revised.

When the RWP is terminated before the end date, a single line is drawn through the end date and a new end date recorded in its place. The person terminating the RWP initials adjacent to the change. Extension of the end date of the RWP must be done per the change procedure noted in the previous section. The RWP can be terminated by the SPM, SS, or designee. As part of the termination of an RWP, the Post-job Radiological Conditions and Closeout Review sections of the RWP shall be completed.

To complete the Post-job Radiological Conditions section, the RCT shall conduct a survey of the worksite governed by the RWP. This survey should be conducted in a manner similar to the pre-job survey and should include determination of the current measurements for all quantities obtained in the pre-job survey. In addition, if personnel monitoring was in effect during work under the RWP and/or an individual was found to have contamination above the monitoring limits, then the appropriate checkbox should be marked.

At a minimum, the closeout review will be conducted by the SS. In cases where the SPM was required to be an approver due to atypical conditions listed in Section 6.2.3, then the SPM shall also perform the closeout review. As part of the closeout review, the reviewer(s) shall verify that associated records for the RWP are noted on the RWP form and that they are present in the project files. Reviewers shall also determine if there were any lessons learned that might be of value to future work to be performed on site. If so, then a lessons learned synopsis shall be written and communicated/incorporated to project personnel.

## **7.0 RECORDS**

Radiation Work Permit Access Log

Radiation Work Permit Authorization Log

## Radiation Work Permit

**8.0 REFERENCES**

<b><i>Number</i></b>	<b><i>Title</i></b>
SOP 006	<i>Radiation and Contamination Surveys</i>
SOP 008	<i>Air Sampling and Sample Analysis</i>
Regulatory Guide 1.86	<i>U.S. Atomic Energy Commission</i>

**9.0 ATTACHMENTS**

Forms provided in this section illustrate the minimum requirements for their respective subject matter. Alternative documents may be used providing the information is presented in a clear and concise manner and the content meets or exceeds the information required to complete these documents.

Attachment 1 – Table 1 Contamination Limits Table

Attachment 2 – Radiation Work Permit Access Log

Attachment 3 – Radiation Work Permit Authorization Log

Attachment 4 – Radiation Work Permit

## ATTACHMENT 1

TABLE 1 - CONTAMINATION LIMITS TABLE

Radionuclides	CAS Number	SURFACES	SOILS <sup>b</sup>	WATER <sup>d</sup>
		Structures, M&E, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	pCi/g <sup>c</sup>	pCi/L
Cesium-137	10045-97-3	5,000	6.6	119
Cobalt-60	10198-40-0	5,000	2.28	100
Plutonium-239	15117-48-3	100	1.38	15
Radium-226	13982-63-3	100	1.0	5 <sup>e</sup>
Strontium-90	10098-97-2	1,000	1.02	8
Thorium-232	7440-29-1	1,000	0.66	15
Tritium (H-3)	10028-17-8	5,000	66	20,000
Uranium-235	7440-61-1	5,000	4.8	30
Uranium-238	7440-61-1	5,000	8.4	30

## Notes:

pCi/g picocurie per gram

pCi/L picocuries per liter

dpm disintegration per minute

a These limits are based on AEC Regulatory Guide 1.86 ([USAEC 1974](#)). Values indicate the measured value above background as determined from the reference area. Limits for removable surface activity are 20 percent of these values.

b These limits are based on Nuclear Regulatory Commission document NUREG-1727, NMSS Decommissioning Standard Review Plan (NRC 2000), whose limits are deemed in compliance with the 25 mrem/y unrestricted dose limit in 10CFR20.1402. Listed values were developed by scaling the NUREG-1727 values to 15 mrem/y unrestricted dose.

c Criteria is above background for those radionuclides found in background soils.

d Release criteria for water have been derived from *Radionuclides Notice of Data Availability Technical Document* ([EPA 2000](#)) Table III, which compared the federal drinking water standards from the 1976 and 1991 Maximum Contaminant Levels. This value reflects the most conservative limit.

e Limit is for total Radium Concentration.



**ATTACHMENT 3 – RADIATION WORK PERMIT AUTHORIZATION LOG**

RWP NUMBER: \_\_\_\_\_ REVISION: \_\_\_\_\_ DATE: \_\_\_\_\_

WORK LOCATION: \_\_\_\_\_ START DATE: \_\_\_\_\_ END DATE: \_\_\_\_\_

Worker Name	Employee ID Number	Current year TEDE (mrem)	*Signature	RCT Authorization	Date

\* By my signature, I indicate that I have read, understand, and will comply with all requirements of this RWP.

---

## ATTACHMENT 4 – RADIATION WORK PERMIT

***Tetra Tech EC, Inc.*****RADIOLOGICAL WORK PERMIT**

Permit Number	
Effective Date	Expiration Date

GENERAL INFORMATION (to be completed by the Requestor)					
Requested by (Name & Project)		Date	Phone No.	Site Mailing Address	
Work Location		Work Area	Building/Site	Extent	Room No.
Work Plan	Health & Safety Plan	Contract Number		Expected Start Date	Expected End Date
<b>Tasks</b> to be performed inside an RCA (add attachment if necessary)				Estimated No. Personnel	Estimated No. Personnel-hours
RADIOLOGICAL LIMITS (to be completed by the RCT)					
<input type="checkbox"/> Anticipated radiological conditions			<input type="checkbox"/> See Attached Map		
<b>Surface Contamination (dpm/100 cm sq)</b>			<b>External Dose Rate (mrem/hr in work area)</b>		
	Direct	Swipe	LAS (Large Area Swipe)		
Alpha	_____	_____	_____	Beta + gamma	_____
Beta/gamma	_____	_____	_____	Neutron	_____
Tritium	_____	_____	_____	Total (b + g + n)	_____
<b>Airborne Radioactivity</b>			DAC		
Radionuclide(s)			<input type="checkbox"/> Anticipated or <input type="checkbox"/> Measured		
Completed by	Name	Signature		ID Number	Date

## Issue and Use of Radiation Work Permits

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ALARA/RADIOLOGICAL PROTECTION REQUIREMENTS (to be completed by RCT)				
<b>Protective Clothing Requirements</b> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"><input type="checkbox"/> None</div> <div style="width: 50%;"><input type="checkbox"/> Rubber Overshoes</div> <div style="width: 50%;"><input type="checkbox"/> Double Coveralls</div> <div style="width: 50%;"><input type="checkbox"/> Lab Coat</div> <div style="width: 50%;"><input type="checkbox"/> Skull Cap</div> <div style="width: 50%;"><input type="checkbox"/> Hood</div> <div style="width: 50%;"><input type="checkbox"/> Double Gloves</div> <div style="width: 50%;"><input type="checkbox"/> Plastic Coverall</div> <div style="width: 50%;"><input type="checkbox"/> Gloves</div> <div style="width: 50%;"><input type="checkbox"/> Booties</div> <div style="width: 50%;"><input type="checkbox"/> Single Coverall</div> <div style="width: 50%;"><input type="checkbox"/> Double Booties</div> <div style="width: 50%;"><input type="checkbox"/> Tape Openings</div> <div style="width: 50%;"><input type="checkbox"/> Other: _____</div> </div>				
<b>Respiratory Requirements</b> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"><input type="checkbox"/> None</div> <div style="width: 50%;"><input type="checkbox"/> Combination cartridge*</div> <div style="width: 50%;"><input type="checkbox"/> Chemical cartridge*</div> <div style="width: 50%;"><input type="checkbox"/> Powered Air Purifying Respirator</div> <div style="width: 50%;"><input type="checkbox"/> Ventilation</div> <div style="width: 50%;"><input type="checkbox"/> Air Line Respirator*</div> <div style="width: 50%;"><input type="checkbox"/> SCBA*</div> <div style="width: 50%;"><input type="checkbox"/> Negative Pressure Respirator</div> <div style="width: 50%;"><input type="checkbox"/> Supplied air suit*</div> <div style="width: 50%;"><input type="checkbox"/> Bubble Hood*</div> <div style="width: 50%;"><b>* Requires SSO approval</b></div> <div style="width: 50%;"><input type="checkbox"/> Other: _____</div> </div>				
<b>Dosimetry Requirements</b> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"><input type="checkbox"/> None</div> <div style="width: 50%;"><input type="checkbox"/> WB dosimeter</div> <div style="width: 50%;"><input type="checkbox"/> Supplemental dosimeter</div> <div style="width: 50%;"><input type="checkbox"/> TLD finger rings</div> <div style="width: 50%;"><input type="checkbox"/> Special neutron dosimetry</div> <div style="width: 50%;"><input type="checkbox"/> Pu access list</div> <div style="width: 50%;"><input type="checkbox"/> Alarming dosimeter</div> <div style="width: 50%;"><input type="checkbox"/> Bioassay sample</div> <div style="width: 50%;"><input type="checkbox"/> Whole-body count</div> <div style="width: 50%;"><input type="checkbox"/> Accident dosimeter</div> <div style="width: 50%;"><input type="checkbox"/> Nasal swipes</div> <div style="width: 50%;"><input type="checkbox"/> Other: _____</div> </div>				
<b>Monitoring Requirements</b> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"><input type="checkbox"/> None</div> <div style="width: 50%;"><input type="checkbox"/> Notify RCT before job starts</div> <div style="width: 50%;"><input type="checkbox"/> Intermittent coverage</div> <div style="width: 50%;"><input type="checkbox"/> Personnel before leaving job</div> <div style="width: 50%;"><input type="checkbox"/> Equipment and tools before removal</div> <div style="width: 50%;"><input type="checkbox"/> Continuous coverage</div> <div style="width: 50%;"><input type="checkbox"/> RCT monitor doffing of PCs</div> <div style="width: 50%;"><input type="checkbox"/> Air monitoring</div> <div style="width: 50%;"><input type="checkbox"/> Self-frisking</div> <div style="width: 50%;"><input type="checkbox"/> Other: _____</div> </div>				
<b>Additional Training Requirements</b> <div style="border-bottom: 1px solid black; height: 20px; width: 100%;"></div>				
<div style="display: flex; justify-content: space-between;"> <input type="checkbox"/> ALARA Pre-job briefing           <input type="checkbox"/> ALARA review (see attachments)         </div>				
<div style="display: flex; justify-content: space-between;"> <b>Completed by RCT</b> Name           Signature           Employee ID Number           Date </div> <div style="margin-top: 5px;"><input type="checkbox"/> Completed</div>				
SPECIAL INSTRUCTIONS (to be completed by the RCT)				
<b>Special Instructions:</b> <div style="border: 1px solid black; height: 150px; width: 100%; margin-top: 5px;"></div>				
<div style="display: flex; justify-content: space-between;"> <b>Completed by RCT</b> Name           Signature           ID Number           Date </div> <div style="margin-top: 5px;"><input type="checkbox"/> Completed</div>				

## Issue and Use of Radiation Work Permits

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APPROVALS					
1.	<b>SS</b>	Name	Signature	ID Number	Date
<input type="checkbox"/>					
2.	<b>SPM</b>	Name	Signature	ID Number	Date
<input type="checkbox"/>					
3.	<b>SSO</b>	Names	Signatures	ID Numbers	Date
<input type="checkbox"/>					
<input type="checkbox"/>					
POST-JOB RADIOLOGICAL CONDITIONS (to be completed by the RCT/HPT)					
<b>Measured Radiological Conditions (Record all readings as highest / general area)</b>				<input type="checkbox"/> See attached map	
Surface Contamination (dpm 100 sq cm) <span style="float: right;">External Dose Rate</span>					
	Direct	Swipe	LAS (large area swipe)	(mrem/hr in work area)	
Alpha	_____	_____	_____	Beta + gamma	_____
Beta/gamma	_____	_____	_____	Neutron	_____
Tritium	_____	_____	_____	Total (b + g + n)	_____
Airborne Radioactivity DAC _____ <input type="checkbox"/> Estimated or Isotope _____ <input type="checkbox"/> Measured			Survey of Personnel Leaving Job Site <input type="checkbox"/> Personnel contaminated above applicable limits <i>(If yes, attach the Radiological Incident Report)</i>		
Completed by RCT	Name	Signature	ID Number	Date	
<input type="checkbox"/> Completed					
REVIEW					
<b>Associated reports for this job (indicate the ones that apply):</b>					
<input type="checkbox"/> CAM Results	<input type="checkbox"/> Nasal swipe data	<input type="checkbox"/> RWP acknowledgement log			
<input type="checkbox"/> Job-specific air monitoring	<input type="checkbox"/> Bioassay sample(s)	<input type="checkbox"/> Dose tracking report			
<input type="checkbox"/> Pre-job survey data	<input type="checkbox"/> Whole Body Count(s)	<input type="checkbox"/> Radiological occurrence/incident report			
<input type="checkbox"/> Post-job survey data	<input type="checkbox"/> Wound count	<input type="checkbox"/> ALARA Pre-job briefing			
<input type="checkbox"/> Finger ring data	<input type="checkbox"/> Skin contamination	<input type="checkbox"/> Formal ALARA review			
<input type="checkbox"/> Special dosimetry results	<input type="checkbox"/> Personal clothing survey	<input type="checkbox"/>			
<input type="checkbox"/> Other: _____					
<input type="checkbox"/> Lessons Learned (If Yes, then briefly explain. Add attachment(s) if necessary)					
Reviewed by RCT	Name	Signature	ID Number	Date	
<input type="checkbox"/> Reviewed					
Reviewed by SPM (or designee)	Name	Signature	ID Number	Date	

# Standard Operating Procedure

## PROJECT DOSIMETRY

SOP 004

Revision 0

Prepared By:

Lauson Bailey  
Project Health Physicist

3/16/2012  
Date

Approved By:

Eric J. Alkensis  
Project Radiation Safety Officer

3/16/2012  
Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

This procedure provides specific guidelines for the control of project dosimetry, occupational radiation exposure records, and maintenance of a personnel exposure history for all Tetra Tech (Tt) full-time and temporary project personnel, subcontractors, visitors and groups for whom monitoring is required.

## 2.0 SCOPE

Radiation monitoring shall be conducted when it is likely that any individual will exceed 10 percent of the annual limits specified in 10 Code of Federal Regulations (CFR) 20.

Subcontractors may use their procedures for conditions or activities not covered by this procedure following approval by Tt.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** - The PHP is responsible for oversight of project dosimetry. The PHP is also responsible for assigning dose for DAC-hrs or bioassay results.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for the implementation of this procedure. This requires conducting periodic reviews of the adherence of personnel to the requirements of this procedure and ensuring that the technicians have appropriate knowledge, training, and experience to perform the requirements of this procedure.

**Site Supervisor** – The Site Supervisor (SS) is responsible for ensuring that the Radiological Control Technicians (RCTs) implement and use this procedure. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technicians** - RCTs are responsible for performing surveys and ensuring the proper use of monitoring devices by workers.

**Personnel** - All personnel are required to wear their issued dosimetry as required by the applicable Radiation Work Permit (RWP) and to maintain their exposure to radiation as low as reasonably achievable (ALARA).

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Bioassay** - The determination of kinds, quantities or concentrations and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

**Committed Dose Equivalent (CDE)** - The dose equivalent to organs or tissues that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

**Committed Effective Dose Equivalent (CEDE)** - The sum of the products of all organs or tissues with CDE and their respective weighting factors.

**Control Badge/Dosimeter** – A dosimeter, identical to those issued to personnel, that is used to monitor exposure in transit and in the storage location. Any dose received by a control badge is subtracted from dose assigned to dosimeters associated with that control badge.

**Deep Dose Equivalent (DDE)** – The dose equivalent of external whole-body exposure at a tissue depth of 1 centimeter (cm) [1,000 milligrams per square centimeter ( $\text{mg}/\text{cm}^2$ )]

**Derived Air Concentration (DAC)** - The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one annual limit intake (ALI). DAC values are given in Table 1, Column 3, of Appendix B of 10 CFR 20 (1-92).

**Direct Reading Dosimeter (DRD)** – A self-indicating, integrating radiation exposure measuring device such as a pocket ion chamber.

**Dose** - The deposition of energy in matter. Dose applies to energy deposited in material by any type of ionizing radiation.

## Project Dosimetry

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**Dose equivalent** - The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

**Dosimeter** – A device, from a National Voluntary Laboratory Accreditation Program (NVLAP)-certified vendor, worn on the body to measure the radiation dose received by the exposed individual.

**Lens Dose Equivalent (LDE)** – The dose equivalent, from external exposure, to the lens of the eye taken at a tissue depth of 0.3 cm (300 mg/cm<sup>2</sup>)

**Monitoring (radiation monitoring, radiation protection monitoring)** – the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

**Quality Factor** – The factor that is radiation-dependent and identifies the relative biological effectiveness of a radiation type and energy. The quality factor is multiplied times the dose to yield the dose equivalent.

**Rad (Radiation Absorbed Dose)** - The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (The SI unit for absorbed dose is the Gray (Gy) 1 Rad = 0.01 Gy).

**Radiation Area (RA)** – Any area accessible to personnel in which there exists ionizing radiation at exposure rates such that an individual could receive a DDE in excess of 2 millirem (mrem) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

**Radiologically Controlled Area (RCA)** – An area containing radioactive materials (in excess of the levels provided in Table 1 of SOP 010, *Radiologically Controlled Areas – Posting and Access Control*) to which access is controlled to protect individuals from exposure to ionizing radiation.

**Rem (Roentgen Equivalent Man)** – The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (The SI unit for dose equivalent is Sv 1 rem=0.01 Sv).

**Shallow Dose Equivalent (SDE)** (also known as skin dose) – The dose equivalent, from external exposure, to the skin of the whole body or the skin of an extremity at a tissue depth of 0.007 cm (7 mg/cm<sup>2</sup>).

**Total Effective Dose Equivalent (TEDE)** – The sum of the DDE (external dose) and the CEDE (internal dose).

## 6.0 PROCEDURE DETAILS

### 6.1 GENERAL

#### 6.1.1 DISCUSSION

Personnel who could potentially receive 10 percent or more of the permissible legal limit for external radiation exposure are required by 10 CFR 20 to be monitored for occupational exposure. In the interests of ALARA, Tt personnel and Tt subcontractors who work in an RCA will be issued and required to wear, at a minimum, a dosimeter. Personnel required to work in areas with dose rates in excess of 2 mrem/hour, will be issued a DRD in addition to their dosimeter.

Prior to commencement of fieldwork, the SPM and PHP will determine the appropriate radiation monitoring dosimetry required based on the radionuclides and activity present at the work area.

#### 6.1.2 PLANNING AND PREREQUISITES

##### 6.1.2.1 Personnel Training

Only personnel who have received appropriate training will be issued dosimetry.

##### 6.1.2.2 Exposure Limits

Nuclear Regulatory Commission (NRC) radiation worker limits:

Whole Body (TEDE)	5 rem/calendar year (yr)
Eye Dose Equivalent	15 rem/yr
Skin Dose Equivalent	50 rem/yr
Organ Dose (CEDE)	50 rem/yr
Embryo/Fetus	0.5 rem/pregnancy

Tetra Tech Administrative control radiation worker limits:

Whole Body (TEDE)	0.5 rem/yr
Eye Dose Equivalent	1.5 rem/yr
Skin Dose Equivalent	5 rem/yr
Organ Dose (CEDE)	5 rem/yr
Embryo/Fetus	0.05 rem/pregnancy

The PRSO, with concurrence from RASO, may approve, where appropriate, exposure above the administrative control limits.

**Project Dosimetry**

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NRC general public exposure limits:

100 mrem/calendar year not to exceed 2 mrem in an hour.

**6.1.2.3 Dosimetry Storage**

When not in use, the dosimetry shall be stored in a low-background area inside the project main office or in other designated storage locations. A control dosimeter shall be kept where the dosimeters are stored when they are not in use. Dosimeters that have not been issued shall also be kept in this storage location whenever possible. If the dosimeters that have not been issued are stored in a different location and/or there is more than one storage location for dosimeters when they are not being worn, each location shall have a control badge.

**6.1.2.4 Cumulative Occupational Dose History**

The PHP or designee shall obtain a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual may have received during the current year. This dose history will be recorded on NRC Form 4 (Attachment 1) or equivalent.

**6.1.2.5 Occupational Dose Report**

The PHP or designee shall maintain records of doses received by individuals for whom monitoring was required by 10 CFR 20, including records of doses received during planned special exposures, accidents, and emergency conditions. This dose record will be reported on NRC Form 5 (Attachment 2) or equivalent.

The PHP or designee shall annually prepare a report of the doses received by individuals for whom monitoring was required by 10 CFR 20 and provide this report to the individuals. This report will be provided on NRC Form 5 (Attachment 2) or equivalent.

**6.2 PROCEDURE PROCESS****6.2.1 EXTERNAL DOSIMETRY**

NVLAP-approved dosimeters are the permanent record of a radiation worker's occupational exposure. Tt personnel and Tt subcontractors who work in an RCA will be issued and required to wear, at a minimum, a dosimeter.

**Project Dosimetry**

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The individual's name, the last four digits of the individual's social security number, issue date, and date of return will be recorded on the Dosimetry Issue Log (Attachment 3) or equivalent.

Personnel issued dosimetry will wear the dosimetry whenever they are working in an RCA or impacted area.

Personnel shall wear a dosimeter for no more than 3 months, or the duration of the project, whichever is shortest. The monitoring period may be extended at the discretion of the PRSO, with concurrence from RASO.

Dosimeters that monitor whole-body DDE shall be worn on the front torso in the region of the torso expected to receive the highest dose. In cases where other areas of the body may receive a higher dose, the PHP or designee shall evaluate and formally require (by specification on the RWP) that the whole-body dosimetry be worn at that body location.

Extremity dosimetry shall be issued when necessary as described by the site-specific RWP.

It is the responsibility of project personnel to return their dosimetry to the SPM or designee at the end of each monitoring period or at the termination of employment.

Dosimetry and any control badges/dosimeters shall be returned in one shipment to the vendor for processing, at the end of each monitoring period.

**6.2.2 DIRECT READING DOSIMETERS**

Personnel working in an RCA may be issued a DRD. DRDs may either be issued for an individual or group depending on the type and duration of work to be performed. The SPM, or designee, will determine if it will be necessary to issue individual or group DRDs. If pocket ion chambers are used for general radiation work, they will have a range of response of zero to 200 millirem.

**6.2.3 VISITORS/GROUP MONITORING**

Visitors are any persons touring or visiting an RCA on an infrequent basis, are escorted while in the restricted area, and do not perform or supervise hands-on work.

A visitor may be escorted into a posted RCA without dosimetry, provided that:

- There will be no entries into radiation areas, surface contamination areas, or airborne contamination areas.
- They remain with an escort who has been issued dosimetry.

## Project Dosimetry

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- Personnel may enter the RCA for short periods of time (not to exceed one month) to do work that does not involve working in an impacted area. Personnel dosimetry will not be required for these individuals. The minimum training for these individuals is the radiological briefing.

**6.2.4 LOST, DAMAGED, AND QUESTIONABLE DOSIMETRY OR IMPROPERLY READING DRD**

In the event of a lost, damaged, or questionable dosimeter or DRD or improperly reading DRD, the individual will exit the RCA immediately and notify the PHP, or designee. A lost, damaged or questionable dosimetry report (see Attachment 4) will be completed and filed in the individual's exposure file. The dose received while the individual was in an exposure situation must be estimated. The estimate of the dose received by an individual may be made based on: 1) dose rates and time in the work area, 2) typical dose received on the type of job, or 3) the dose received by another person during the same type of work and stay time in the same area.

In the case of a lost damaged or improperly reading DRD, the PHP may deem it necessary to send the individual's personal dosimeter in for immediate processing. The dose determined shall be added to the dose record at the discretion of the PHP, or designee. The PHP, or designee, shall review, approve, and maintain all completed dose estimates.

In the event of multiple occurrences, the PHP shall be notified immediately.

**6.2.5 INTERNAL DOSIMETRY****6.2.5.1 DAC-Hr Tracking**

Air sampling results are used by the PHP or designee to calculate DAC-hrs of exposure for an exposed worker. If an individual is exposed to airborne radioactivity that is  $> \frac{1}{10}$  1 DAC-hr but  $\leq 10$  DAC-hrs in any consecutive 7-day period, then the DAC-hr estimate is converted to dose equivalent at the rate of 2.5 mrem per DAC-hr for the most limiting isotope of concern. The PHP or designee shall document all such calculations and a copy of this document shall be placed in the worker's exposure file. Notifications will be made to the PRSO and Radiological Affairs Support Office (RASO).

**6.2.5.2 Bioassay**

A bioassay shall be performed whenever personnel have been, or are expected to be exposed to  $>10$  DAC-hrs in any consecutive 7-day period. This should be based on air sampling data, accident conditions, external contamination, or other conditions that indicate an exposure of  $>10$  DAC-hrs might have occurred.

If a worker returns a verified positive bioassay, the PHP or designee shall assign an internal dose equivalent (CEDE or CDE as appropriate) to the worker's exposure file.

## Project Dosimetry

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The PHP or designee shall use accepted and documented methods to calculate this dose. This may include health physics software, or technical reports by the National Council on Radiation Protection and Measurements (NCRP) and International Commission on Radiological Protection (ICRP). Notifications will be made to the PRSO and Radiological Affairs Support Office (RASO).

#### 6.2.5.3 Calculation of Total Dose

Whenever an internal dose is calculated or assigned, the PHP or designee shall add this to the external DDE measured by the worker's dosimeter. This total dose (TEDE) shall be reported to the worker and filed in the worker's dosimetry file.

#### 6.2.6 SHALLOW DOSE FROM SKIN CONTAMINATION

In the event of a skin or clothing contamination event, as described in SOP 022, *Radiological Protective Clothing Selection, Monitoring and Decontamination*, the PHP or designee shall calculate a SDE for the worker. The PHP or designee shall use accepted and documented methods to calculate this dose. This may include health physics software or technical reports by the NCRP and ICRP. This dose shall be reported to the PRSO, worker and filed in the worker's dosimetry file.

### 7.0 RECORDS

The following records will be generated and retained in the permanent project file as a result of using this procedure:

- Cumulative Occupational Dose History (NRC Form 4)
- Occupational Dose Record (NRC Form 5)
- Dosimetry Issue Log
- Lost, Damaged or Questionable Dosimetry Report

### 8.0 REFERENCES

<i>Number</i>	<i>Title</i>
SOP 010	Radiologically Controlled Areas – Posting and Access Control
SOP 022	Radiological Protective Clothing Selection, Monitoring And Decontamination

### 9.0 ATTACHMENTS

Attachment 1 – Cumulative Occupational Dose History (NRC Form 4)

**Project Dosimetry**

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Attachment 2 – Occupational Dose Record (NRC Form 5)

Attachment 3 - Dosimetry Issue Log

Attachment 4 – Lost, Damaged or Questionable Dosimetry Report

## Project Dosimetry

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## ATTACHMENT 1 – Cumulative Occupational Dose History (NRC Form 4)

NRC FORM 4 (10/2001) 10 CFR PART 20		U.S. NUCLEAR REGULATORY COMMISSION		APPROVED BY OMB NO. 3150-0006		EXPIRES: 10/31/2004	
<p align="center"><b>CUMULATIVE OCCUPATIONAL DOSE HISTORY</b></p> <p><small>Estimated burden per response to comply with this mandatory information collection request: 30 minutes. The record is used to ensure that doses to individuals do not exceed regulatory limits. This information is required to record an individual's lifetime occupational exposure to radiation to ensure that the cumulative exposure to radiation does not exceed regulatory limits. Send comments regarding the burden estimate to the Records Management Branch (T-8733), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0031, or by internet e-mail to <a href="mailto:rule@nrc.gov">rule@nrc.gov</a>, and to the Desk Officer, Office of Information and Regulatory Affairs, NIOSH, Room 4050, Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.</small></p>							
1. NAME (LAST, FIRST, MIDDLE INITIAL)		2. IDENTIFICATION NUMBER		3. ID TYPE		4. SEX MALE <input checked="" type="checkbox"/> FEMALE <input type="checkbox"/>	
5. MONITORING PERIOD (MM/DD/YYYY - MM/DD/YYYY)		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ESTIMATE NO RECORD	
11. DDE	12. LDE	13. SDE, VBS	14. SDE, NE	15. CEDE	16. CDE	17. TEDE	18. TODE ROUTINE PSE
5. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ESTIMATE NO RECORD	
11. DDE	12. LDE	13. SDE, VBS	14. SDE, NE	15. CEDE	16. CDE	17. TEDE	18. TODE ROUTINE PSE
5. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ESTIMATE NO RECORD	
11. DDE	12. LDE	13. SDE, VBS	14. SDE, NE	15. CEDE	16. CDE	17. TEDE	18. TODE ROUTINE PSE
5. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ESTIMATE NO RECORD	
11. DDE	12. LDE	13. SDE, VBS	14. SDE, NE	15. CEDE	16. CDE	17. TEDE	18. TODE ROUTINE PSE
5. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ESTIMATE NO RECORD	
11. DDE	12. LDE	13. SDE, VBS	14. SDE, NE	15. CEDE	16. CDE	17. TEDE	18. TODE ROUTINE PSE
5. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ESTIMATE NO RECORD	
11. DDE	12. LDE	13. SDE, VBS	14. SDE, NE	15. CEDE	16. CDE	17. TEDE	18. TODE ROUTINE PSE
19. SIGNATURE OF MONITORED INDIVIDUAL		20. DATE SIGNED		21. CERTIFYING ORGANIZATION		22. SIGNATURE OF DESIGNEE	
						23. DATE SIGNED	

NRC FORM 4 (10/2001)

## Project Dosimetry

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## ATTACHMENT 2 – Occupational Dose Record (NRC Form 5)

NRC FORM 5 (9-2004) 19 CFR PART 23				U.S. NUCLEAR REGULATORY COMMISSION		APPROVED BY OMB NO.3160-0008		EXPIRES: 09/30/2007	
<b>OCCUPATIONAL DOSE RECORD FOR A MONITORING PERIOD</b>									
1. NAME (LAST, FIRST, MIDDLE INITIAL)				2. IDENTIFICATION NUMBER		3. ID TYPE		4. SEX <input type="checkbox"/> MALE <input type="checkbox"/> FEMALE	
5. MONITORING PERIOD (MM/DD/YYYY - MM/DD/YYYY) **				7. LICENSEE NAME		8. LICENSE NUMBER(S)		9A. <input type="checkbox"/> RECORD <input type="checkbox"/> ESTIMATE	
9B. <input type="checkbox"/> ROUTINE <input type="checkbox"/> PSE									
<b>INTAKES</b>				<b>DOSES (In rem)</b>					
10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN * CI	DEEP DOSE EQUIVALENT (DDE) 11.					
				LENS (EYE) DOSE EQUIVALENT (LDE) 12.					
				SHALLOW DOSE EQUIVALENT, WHOLE BODY (SDE, WB) 13.					
				SHALLOW DOSE EQUIVALENT, MAX EXTREMITY (SDE, ME) 14.					
				COMMITTED EFFECTIVE DOSE EQUIVALENT (CEDE) 15.					
				COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN (CDE) 16.					
				TOTAL EFFECTIVE DOSE EQUIVALENT (ADD BLOCKS 11 AND 16) (TEDE) 17.					
				TOTAL ORGAN DOSE EQUIVALENT MAX ORGAN (ADD BLOCKS 11 AND 16) (TODE) 18.					
19. COMMENTS									
20. SIGNATURE - LICENSEE								21. DATE PREPARED	

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Dosimeter Series:

[illegible]

## Project Dosimetry

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**ATTACHMENT 4 – Lost, Damaged, or Questionable Dosimetry Report****ADMINISTRATIVE**

REPORT DATE / TIME: \_\_\_\_\_

PROJECT NAME / NUMBER: \_\_\_\_\_

PROJECT MANAGER / CONTACT: \_\_\_\_\_

INDIVIDUAL'S NAME / SSN LAST 4: \_\_\_\_\_

DOSIMETER NUMBER / TYPE: \_\_\_\_\_

DATE / TIME OF INCIDENT: \_\_\_\_\_

LOCATION (IF KNOWN): \_\_\_\_\_

APPLICABLE RWP NUMBER: \_\_\_\_\_

DATE DOSIMETER WAS ISSUED: \_\_\_\_\_

**DOSE CALCULATION**

1. DOSE FROM DOSIMETER READINGS: \_\_\_\_\_ (TOTAL FROM DATE ISSUED) THRU \_\_\_\_\_ (DATE) = \_\_\_\_\_ MREM

2. CURRENT DOSIMETER READING: \_\_\_\_\_ (IF MORE THAN ONE DOSIMETER, USE HIGHEST) = \_\_\_\_\_ MREM

3. IF INDIVIDUAL WAS NOT WEARING A DOSIMETER, OR LOST HIS DOSIMETER, ASSIGN HIGHEST EXPOSURE RECEIVED BY WORKERS IN THE SAME AREA. IF NONE, USE DOSE RATE X TIME IN AREA FOR THE SAME PERIOD.

DOSE RATE: \_\_\_\_\_ (MREM / HOUR) X \_\_\_\_\_ (HOUR S) = \_\_\_\_\_ MREM

HIGHEST DOSIMETER READING \_\_\_\_\_ MREM = \_\_\_\_\_ MREM

4. TOTAL ESTIMATED EXPOSURE TO BE ASSIGNED: \_\_\_\_\_ = \_\_\_\_\_ MREM

THE METHOD USED TO ESTIMATE MY EXPOSURE HAS BEEN EXPLAINED TO ME, AND THE ESTIMATED DOSE ASSIGNED TO MY RECORD IS ACCEPTABLE FOR THIS EVENT.

EMPLOYEE'S SIGNATURE: \_\_\_\_\_ DATE: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

**DOSE RECORD AUTHORIZATION**

DOSE ESTIMATE CALCULATED BY: \_\_\_\_\_ DATE: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

DOSE ESTIMATE REVIEWED BY: (PHP) \_\_\_\_\_ DATE: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

DOSE ESTIMATE POSTED BY: \_\_\_\_\_ DATE: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

**Standard Operating Procedure**  
**RADIATION AND CONTAMINATION SURVEYS**

**SOP 006**

**Revision 0**

Prepared By:

Lauson Bailey  
Project Health Physicist

3/16/2012

Date

Approved By:

Eric J. Alkensis  
Project Radiation Safety Officer

3/16/2012

Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

The purpose of this procedure is to specify methods and requirements for radiological surveys and documentation of acquired data.

Adherence to this procedure will provide reasonable assurance that the surveys performed have reproducible results. This guidance for control of radiation exposures provided in this procedure is in accordance with the as low as reasonably achievable (ALARA) philosophy.

This procedure will be used by Tetra Tech (Tt) personnel and its subcontractors to perform radiation and contamination surveys.

## 2.0 SCOPE

This procedure shall be implemented by Tt staff and subcontractor personnel when conducting radiation or contamination surveys.

Subcontractors may use their procedures for conditions or activities not covered by this procedure following approval by Tt and the Radiological Affairs Support Office (RASO).

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** - The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Project Manager** - The Site Project Manager (SPM) is responsible for ensuring that personnel performing the tasks required by this procedure are properly assigned. The SPM is responsible for the training of personnel working with radioactive materials.

The SPM is responsible for ensuring that personnel conducting radiation and contamination surveys are familiar with the requirements of this SOP and have access to a copy of the Radiation Work Permits (RWP). Survey documentation will be reviewed SPM or designee.

**Site Supervisor** - The Site Supervisor (SS) is responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for the control of radioactive material, coverage of radiation workers, and to ensure that personnel under their cognizance observe proper precautions.

**Radiological Control Technician** - The Radiological Control Technician (RCT) shall be responsible for the performance of the requirements of this procedure and documentation of work performed.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Activity** - The rate of disintegration (transformation) or decay of radioactive material. The units of activity for the purpose of this procedure are disintegrations per minute (dpm) for loose and fixed surface contamination, picocuries per gram (pCi/g) for soil, or microcuries per milliliter ( $\mu\text{Ci/mL}$ ) for airborne contamination.

**Contamination** - Deposition of radioactive material in any place it is not desired. Contamination may be due to the presence of alpha particle, beta particle or gamma ray emitting radionuclides.

**Exposure Rate** - The amount of radiation (exposure) delivered at a given point per unit time. Typical units are microroentgen per hour ( $\mu\text{R/hr}$ ).

**Fixed Contamination** - Radioactive contamination that is not readily removed from a surface by applying light to moderate pressure when wiping with a paper or cloth disk swipe, or masslin.

**Minimum Detectable Activity (MDA)** - For purposes of this procedure, MDA for removable radioactive contamination is defined as the smallest amount of sample activity that will yield a net count with a 95 percent confidence level based upon the background count rate of the laboratory counting instrument used.

**Minimum Detectable Concentration (MDC)** - For purposes of this procedure, MDC is the *a priori* activity level that a specific instrument and technique can be expected to detect 95 percent of the time for portable survey instruments.

**Radiation Work Permit (RWP)** - A document generated in accordance with SOP 002 to provide:

- A description and scope of the work to be performed
- The existing radiological conditions in the work area
- The radiological limits of applicability for the RWP, if radiation levels exceed limits then a new RWP or a modification to the existing RWP must be made
- The protective measures to be employed during the work to protect the worker(s)
- The period of time the RWP is valid
- Special instructions to workers and RCTs during the course of work
- The proper approvals required to begin work

**Radiologically Controlled Area (RCA)** – An area containing radioactive materials (in excess of the levels provided in Table 1 of Standard Operating Procedure SOP 010, *Radiologically Controlled Areas – Posting and Access Control*) to which access is controlled to protect individuals from exposure to contamination and ionizing radiation.

**Removable Surface Contamination** - Radioactive contamination that is readily removed from a surface by applying light to moderate pressure when wiping with a paper or cloth disk swipe, or masslin.

**Uncontrolled Area** - An uncontrolled area is any area where access is not controlled for radiological purposes.

## 6.0 PROCEDURE DETAILS

### 6.1 GENERAL

Radiation surveys are performed to identify radiation areas, measure the exposure rate, and assess the intensity and shape of those areas to determine control requirements at the worksite.

Contamination surveys are conducted to detect loose surface contamination and fixed contamination. Loose surface contamination is normally detected indirectly by a swipe sample or wipe performed on the item or surface of interest. Fixed contamination levels are measured directly.

Survey results, locations, and any unusual conditions shall be documented and described on Attachments 1 and 2, Radiation/Contamination Survey Form and Radiation/Contamination Survey Supplement, respectively.

When performing surveys, express readings as the actual observed number. Do not report “<MDA” or “<Bkg”. When background corrections are made, results may be expressed as negative numbers as applicable.

### 6.1.1 DISCUSSION

Radiation and contamination surveys shall be performed on an as-needed basis. The need for performing a survey is identified by, but not limited to the following conditions:

- An RWP is needed to perform an approved job.
- A condition exists where radiological data are needed.
- An investigation is required due to abnormal conditions or indications.
- An ongoing job requires a survey to update radiological postings and/or an RWP.
- As required to support *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM; NUREG-1575) based survey activities.

### 6.1.2 PLANNING AND PREREQUISITES

Instruments used to perform radiation and contamination surveys shall be operated in accordance with their operation procedure. Steps to be completed during the planning phase include the following:

- Obtain and review any site-specific survey plans [such as a Task-specific Plan (TSP), work instruction, and time-critical removal action (TCRA) Work Plan] and previous surveys performed in the area.
- Obtain appropriate survey instruments and prepare the instruments for use.
- Obtain the necessary forms, swipes, and protective clothing that will be used during the survey.

Prior to entering an area to perform a survey, each radiation detection instrument shall be:

- Battery Checked.
- Checked for obvious physical damage.
- Quantitatively response-checked daily, prior to use.
- Checked to ensure that the instrument calibration is current.

If any of the above conditions are unsatisfactory, the instrument shall be tagged out of service and not used.

## 6.2 PROCEDURE PROCESS

### 6.2.1 EXPOSURE SURVEYS

When entering posted or suspected high radiation areas, or unknown areas, the instrument range selector switch (if applicable) shall be selected to the highest range and moved down through the lower ranges until the meter indicates on scale.

Always survey a sufficient number of locations to determine average and maximum general area and contact radiation levels.

A Ludlum Model-19 or equivalent should be used for performing exposure rate surveys for gamma radiation. The instrument should be operated in accordance with the manufacturer supplied operations manual and any applicable requirements from work specific documents (i.e. work instructions or TSPs). Care should be taken to ensure that the instrument has been allowed to stabilize between individual measurements.

When performing general area exposure rate surveys, the RCT should:

- Attempt to determine the source of radiation fields.
- Record the highest level as the general area exposure rate.
- Perform contact exposure rate measurements with the detector within 1 inch of the surface to be surveyed.
- Perform surveys at approximately 1 meter (waist level) from surface to establish posting requirements for the area.
- Verify the exposure rates of known hot spots.

## 6.2.2 REMOVABLE CONTAMINATION SURVEYS

### 6.2.2.1 Removable Contamination Swipe

The following guidance shall be used unless an approved site-specific survey/work instruction directs otherwise. Specific survey instructions will be prepared and given in work specific documents (i.e. work instructions or TSPs) for radioisotopes requiring unusual sampling techniques, such as tritium ( $^3\text{H}$ ).

### 6.2.2.2 Swipe Surveys

1. Label or number swipes, as necessary, to identify each swipe.
2. Wipe the swipes over approximately 100 square centimeters ( $\text{cm}^2$ ) (16 square inches) of the surface to be sampled.
3. Apply moderate pressure.
4. Exercise care on rough surfaces so as not to tear the swipes.
5. Exercise care on wet surfaces so as not to degrade the swipes. Ensure that surfaces are not submerged in water and that cloth swipes or similar are used on wet/damp surfaces.

When surveying an area:

1. Obtain swipes from sample points, which are representative of the average and maximum contamination levels in the area, as identified during preliminary surveys. These areas could include:
  - a. Areas of high traffic
  - b. On and under benches or tables
  - c. Beneath piping and components
  - d. On accessible wall surfaces
  - e. On piping and significant components
  - f. Near drains, sumps and low spots
2. Swipe floor and component surfaces, which display evidence of (potentially) contaminated water leakage.
3. Ensure contamination is not spread to clean areas when obtaining swipes.

When surveying equipment:

1. Obtain swipes on large surfaces.
2. Obtain swipes in cracks or crevices where contamination may have settled.
3. Obtain swipes on openings to internal surfaces.
4. Handle swipes in a manner that will prevent cross-contamination such as by placing each swipe in a separate envelope.

#### 6.2.2.3 Counting Swipes

A Ludlum Model 2929 scaler with a Model 43-10-1 ZnS(Ag) scintillation probe (or equivalent) will normally be used for counting swipes.

Swipes will be counted in the field with a portable instrument. If high levels are identified the counting lab will be notified.

1. Count the swipes in accordance with the operating procedure for the instrument.
2. Record swipe results in dpm/100 cm<sup>2</sup>.
3. Store/archive used swipes as radioactive material until disposal is approved by RASO.

#### 6.2.2.4 Removable Contamination Surveys Using Large-area Wipes (LAWs)

Large-area contamination surveys using LAWs are appropriate for monitoring the radiological cleanliness of non-contaminated areas or equipment, to track area

decontamination progress, or for initially verifying that surfaces are free from contamination.

There are no specific requirements concerning the amount of area to be wiped when performing LAWs. The area wiped should be determined based on the use of the survey data and the dust loading of the LAW material.

#### 6.2.2.5 Performing LAWs

Use masslin, oil-impregnated cloths, or equivalent media to perform LAWs. Select an appropriate collection material and method based upon the survey conditions such as wet surfaces, rough surfaces, heavily soiled area and oily and greasy surfaces.

1. Label or number the cloths, as necessary, to assist in determining the location of the sample.
2. Determine the size of the area to be sampled based on the results of the survey.
3. Wipe the collection media over the surface using moderate pressure by hand, with a masslin mop, or other approved techniques.

#### 6.2.2.6 Evaluating LAWs

1. Allow wet swipe to dry prior to counting.
2. Scan the swipe with an appropriate field instrument (2221/43-68, or equivalent), in an area with a low background.
3. Hold the detector within ½ inch or less above the swipe and move the detector over the swipe at a maximum rate of 1 inch per second.
4. If any indication of an increased count rate is noted, pause to allow the meter reading to stabilize.
5. If the swipe reading is indistinguishable from background, consider the surveyed surface to be free from contamination. If the LAW reading is greater, conduct further surveys, using swipes over a 100 cm<sup>2</sup> area, to isolate the boundaries of the contamination.
6. Dispose of used LAW media as radioactive waste if there is any detectable activity observed above background.

### 6.2.3 SURVEYS FOR FIXED ALPHA/BETA CONTAMINATION

Fixed contamination surveys are used to obtain indications of fixed contamination levels on surface areas, pieces of equipment, or tools for characterization and/or release surveys. Fixed contamination surveys are also performed to assess if residual contamination is present greater than the release criteria for the radionuclide(s) of concern.

A Ludlum Model-2221/43-68 or equivalent should be used for performing fixed contamination surveys for alpha and beta radiation.

#### 6.2.3.1 Scan Surveys

1. When surveying for fixed alpha/beta contamination, the probe should be held within 1/4 inch or less from the surface being surveyed. The movement rate of the detector probe should be 1 inch per second or slower.
2. Whenever practical, 100 percent of accessible areas being surveyed should be direct scan surveyed, unless the applicable work planning document indicates otherwise.
3. Scan ranges are documented as the range from the lowest measurement to the highest measurement observed.

#### 6.2.3.2 Static Surveys

1. Count time for conducting static measurements will be dependent upon the isotope of concern and the MDA for the instrument being used.
2. Static measurements should be performed at regions showing the highest indicated reading during the scan survey or as required by a work specific document (i.e. TSP or work instruction) or frequently enough to ensure the detection of residual activity.
3. When taking a static measurement for fixed alpha/beta contamination, the probe should be held within 1/4 inch or less from the surface being surveyed.
4. Results should be reported in units of net counts per minute (cpm) above background or dpm/100 cm<sup>2</sup>.

The following formula should be used for converting direct probe readings from cpm to dpm/100 cm<sup>2</sup>:

$$A_S = \frac{R_{S+B} - R_B}{\varepsilon_i \varepsilon_s \frac{W_A}{100 \text{ cm}^2}}$$

where,

$A_S$  = total surface activity (dpm/100 cm<sup>2</sup>)

$R_{S+B}$  = the gross count rate of the measurement in cpm,

$R_B$  = the background count rate in cpm

$\varepsilon_i$  = the instrument efficiency (counts per particle)

$\varepsilon_s$  = the contaminated surface efficiency (particles per disintegration)

$W_A$  = the physical area of the detector window (cm<sup>2</sup>)

In the absence of experimentally determined surface efficiencies, ISO-7503-1 and NUREG-1507, provide conservative recommendations for surface efficiencies. ISO-7503-1, recommends a surface efficiency of 0.25 for alpha emitters. NUREG-1507 provides surface efficiencies based on studies performed primarily at Oak Ridge Institute for Science and Education (ORISE). A surface efficiency of 0.25 will be used for alpha/beta emitters.

#### 6.2.4 GAMMA SURVEYS

A Ludlum Model 12 or equivalent should be used for gamma radiation surveys.

A single detector or an array of detectors may be used to perform gamma scans.

##### 6.2.4.1 Scan Surveys

1. Set the audio response switch to the “on” position.
2. If a single detector is used, traverse a path at a maximum speed of approximately 0.5 meters per second and slowly move the detector assembly in a serpentine (S-shaped) pattern, while maintaining the detector approximately 10 centimeters (cm) (4 inches) from the area being surveyed.
3. If a detector array is used, it will be pushed or pulled in a straight line with the detector centers positioned approximately 30 cm apart.
4. Scan ranges should be recorded from the lowest reading to the highest reading noted.
5. If data logging is being performed, the scan data will be collected at the time interval necessary to obtain the measurements required for the survey.
6. Locations of radiation levels greater than 3 standard deviations above background shall be marked and identified for further investigations.
7. Measurement results are recorded in cpm.

##### 6.2.4.2 Static Surveys

1. Static gamma measurements require positioning the detector assembly approximately 10 cm (4 inches) above the surface and completing a stationary 60-second survey.
2. Static measurements should be performed as required in the applicable work planning document or frequently enough to ensure the detection of residual activity.
3. Measurement results are recorded in cpm.

## 6.2.5 ROUTINE RADIOLOGICAL SURVEYS

### 6.2.5.1 Frequency Requirements for Routine Surveys

Appropriate routine radiological surveys shall be performed at the following frequencies unless directed otherwise by the applicable work planning document or the PHP or designee.

#### Exposure Rate Surveys

Surveys should be performed as frequently as necessary to ensure that radiological postings accurately reflect actual conditions during activities that have the potential to change exposure rates. Additionally, radiation surveys should be performed under the following circumstances:

- Upon initial entry into potential radiation areas after extended periods of closure.
- Daily, in the vicinity of contamination concentration points on operating high-efficiency particulate air (HEPA)-filtered ventilation units.
- Weekly, in occupied office spaces located inside radiologically controlled areas.
- Weekly, or upon entry if entries are less frequent than weekly, inside radiation areas and radioactive material storage areas.
- Weekly, along radiation area boundaries to ensure that the radiation areas do not extend beyond the posted boundaries.

#### Contamination Surveys

- Daily when in use, or once per shift in high-use situations at contamination control points, radiological change areas, or step-off pads.
- Daily, in count rooms and laboratories that are used to analyze potentially contaminated samples.
- Daily, in office spaces located inside radiologically controlled areas.
- Daily, in lunchrooms, eating areas, locker rooms and shower areas adjacent to radiologically controlled areas.
- Weekly, for all designated lunchrooms and offices for the project.
- Weekly, or upon entry if entries are less frequent, in the areas where radioactive materials are handled or stored.
- Weekly, or upon entry if entries are less frequent, in posted contamination areas.

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**Radiation and Contamination Surveys**

Revision 1 – Page 14 of 20

**6.2.5.2 Identifying and Scheduling Routine Radiological Surveys**

The PHP or designee shall identify and schedule routine surveys as required by the radiological conditions and work activities.

Routine survey schedules shall be developed using a standard system for designating surveys as follows:

Frequency of survey:

Daily	D
Weekly	W
Monthly	M
Quarterly	Q
Semiannually	S
Annually	A
Upon Entry	U

Routine survey schedules shall be submitted to and approved by the PHP or designee.

Routine survey tracking forms should be prepared using the approved routine survey schedules.

Changes to any routine survey schedule shall be submitted to and approved by the PHP, or designee.

**6.2.5.3 Survey Log**

Completion of surveys shall be documented using the assigned survey log (see Attachment 3) for the project. This is not limited to initial surveys but includes routine surveys. Each survey shall be assigned a unique tracking number consistent with the practices of the project.

**6.2.5.4 Performance of Routine Surveys**

RCTs shall perform routine surveys in accordance with the RWP and the other applicable procedures.

Upon completion of a routine survey, the RCT shall initial the appropriate Survey Log.

**Radiation and Contamination Surveys**

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**6.2.5.5 Periodic Evaluation of Routine Surveys**

Routine survey schedules (see Attachment 4) shall be reviewed and updated periodically to ensure that all areas within the project boundaries are receiving appropriate routine survey coverage.

Changes of conditions within the project area will be reported to the PHP or designee and may require a modification of the routine radiological survey schedule and/or RWP.

**6.2.5.6 Management Notification**

The PHP shall be notified, in writing by the SPM, of any failure to complete a routine survey as scheduled. The missed survey will be completed as soon as possible after the discovery that it was missed.

**7.0 RECORDS**

Radiation/Contamination Survey Form

Radiation/Contamination Survey Supplement

Survey Log

Routine Survey Schedule

**8.0 REFERENCES**

<b>Number</b>	<b>Title</b>
10 CFR 20	<i>Standards for Protection Against Radiation</i>
ISO-7503-1	<i>Evaluation of Surface Contamination</i>
NUREG-1507	<i>Minimum Detectable Concentration/Activities for Typical Radiation Survey Instruments for Various Contaminants and Field Conditions</i>
NUREG-1575	<i>Multi-Agency Radiation Survey and Site Investigation Manual</i>
SOP 002	<i>Issue and Use of Radiation Work Permits</i>

**9.0 ATTACHMENTS**

Forms provided in this section illustrate the minimum requirements for their respective subject matter. Alternative documents or electronic data logging may be used providing the information is presented in a clear and concise manner and the content meets or exceeds the information required to complete these documents.

**Radiation and Contamination Surveys**

Revision 1 – Page 16 of 20

Attachment 1, Radiation/Contamination Survey Form

Attachment 2, Radiation/Contamination Survey Supplement

Attachment 3, Survey Log

Attachment 4, Routine Survey Schedule

**ATTACHMENT 1 – RADIATION/CONTAMINATION SURVEY FORM**

DATE:	TIME:	INSTRUMENTATION USED				
SURVEY NUMBER:	Model Inst/Det.	Serial Number	Calibration Due Date	% Efficiency	MDC/MDA (dpm/100cm <sup>2</sup> )	Background (dpm/100cm <sup>2</sup> )
LOCATION:						
SURVEYOR:						
REVIEWED BY:						
PHP/SPM:						
Isotopes of Concern:						
Description or drawing:						
Routine (Daily / Weekly / Monthly) <input type="checkbox"/>				Non-routine <input type="checkbox"/>		

All radiation readings in  $\mu\text{r/hr}$  unless otherwise noted.

Ⓢ . . . . denotes swipe location or fixed  $\alpha/\beta$  readings.

# . . . . . denotes G/A radiation readings.

# / # . . . denotes contact / 1 meter radiation readings.

\* . . . . . denotes highest radiation reading on contact.

Δ . . . . . denotes static location.

## Radiation and Contamination Surveys

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## ATTACHMENT 2 - RADIATION/CONTAMINATION SURVEY SUPPLEMENT

SURVEY NUMBER:								
SURVEYOR:					LOCATION:			
Location	Exposure Rate ( $\mu$ R/hr)		Fixed + Removable			Removable		Comments
	Contact	1 Meter	Gamma (cpm)	Alpha dpm/probe	Beta/Gamma dpm/probe	Alpha dpm/100cm <sup>2</sup>	Beta/Gamma dpm/100cm <sup>2</sup>	
1								
2								
3								
4								
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24								
25								
Reviewer			Date/Time:		PHP/SPM		Date/Time:	

**Project:**

**Location:** \_\_\_\_\_

[illegible]

Reviewed/Approved By: \_\_\_\_\_ / \_\_\_\_\_  
 \_\_\_\_\_ PHP/SPM \_\_\_\_\_ Date

## Radiation and Contamination Surveys

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## ATTACHMENT 4 – ROUTINE SURVEY SCHEDULE

Survey Description	January	February	March	April	May	June	July	August	September	October	November	December
	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init
	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
	#	#	#	#	#	#	#	#	#	#	#	#
	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init
	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
	#	#	#	#	#	#	#	#	#	#	#	#
	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init
	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
	#	#	#	#	#	#	#	#	#	#	#	#
	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init
	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
	#	#	#	#	#	#	#	#	#	#	#	#
	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init	Surveyor Init
	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
	#	#	#	#	#	#	#	#	#	#	#	#

Prepared/Submitted By: \_\_\_\_\_ / \_\_\_\_\_  
 Technician Date

Reviewed/Approved By: \_\_\_\_\_ / \_\_\_\_\_  
 PHP/SPM Date

**Standard Operating Procedure**

**PREPARATION OF PORTABLE RADIATION  
AND CONTAMINATION SURVEY METERS AND  
INSTRUMENTS FOR FIELD USE**

**SOP 007**

**Revision 0**

Prepared By:

Lauson Bailey  
Project Health Physicist

3/16/2012

Date

Approved By:

Eric J. Alkensis  
Project Radiation Safety Officer

3/16/2012

Date

---

**Preparation of Portable Radiation and Contamination  
Survey Meters and Instruments for Field Use**

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**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## **1.0 PURPOSE**

This procedure is used to specify the general requirements for preparing portable radiation and contamination survey meters and instruments for use at field locations. The procedures presented below will be supplemented by the specific instrument operation manuals, Tetra Tech (Tt)-approved subcontractor procedures and specific work documents (i.e. Task-specific Plans (TSPs), work instructions, and other Work Plan documents).

## **2.0 SCOPE**

This procedure will be used by Tt personnel and its subcontractors. This procedure is intended to provide general instructions for preparing radiation and contamination survey meters and instruments for field operations.

## **3.0 MAINTENANCE**

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## **4.0 RESPONSIBILITIES**

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for monitoring compliance with this procedure and training personnel in the use of the radiation and contamination survey meters and instruments. The SPM will assist in the interpretation of results obtained during surveys. The SPM will also be responsible for performing periodic surveillance of the use and maintenance of instruments and ensuring that the instruments are calibrated at specified intervals, ensuring that records pertaining to the instrument are maintained on file throughout the duration of the project and copies retained in the permanent project file, and reviewing documentation generated by the use of this procedure.

**Site Supervisor** – The Site Supervisor (SS) is responsible for ensuring that all personnel assigned the task of operating radiation and contamination survey meters and instruments are familiar with this procedure and are adequately trained with the specific instrument being used to perform surveys. The SS is responsible for ensuring that a copy of this procedure is available at the job site. The SS will also be responsible for ensuring that Radiological Control Technicians (RCTs) are qualified by training and experience to perform the requirements of this procedure, notifying the SPM of any unsafe or unusual conditions observed during operation of the instrument, and implementation of this procedure. The SS shall be responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for ensuring that RCTs implement and use this procedure. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technician** – The RCT is responsible for being qualified by training and experience to perform the requirements of this procedure, notifying the SS of any unsafe or unusual conditions observed during operation of the instrument, and implementation of this procedure.

## **5.0 DEFINITIONS AND ABBREVIATIONS**

**Acceptance Range** – A range of values that describes an acceptable instrument check result. An acceptance range is typically determined by adding  $\pm 20$  percent or  $\pm 2\sigma$  to the expected value.

**Calibration Sticker** – A label affixed to a properly calibrated instrument. The calibration sticker shall be applied by the calibration facility. The calibration sticker should indicate the date through which the calibration is valid.

**Chi-Square Test** – A probability density function that gives the distribution of the sum of the squares of a number of independent random variables each with a normal distribution with zero mean and unit variance, that has the property that the sum of two or more random variables with such a distribution also has one, and that is widely used in testing statistical hypotheses especially about the theoretical and observed values of a quantity and about population variances and standard deviations. This test is used to evaluate the operation of an instrument, generally upon return from calibration.

**Check Log** – A form or series of forms which are used to document that an instrument was checked prior to usage in the field. Check logs can consist of multiple pages and must contain at least one page identifying the instrument. At least one page must also specify the parameters (source, geometry, etc.) used for the daily check. Space shall be provided to document the daily tests in the log. The log should be designed so as to clearly associate the required verifications with the signature or initials of the individual performing the check and date of each check.

**Instrument Efficiency** – A measure of the response (counts) obtained with a particular instrument/probe combination when exposed to a known fluence of radioactive particles. Instrument efficiency has units of counts per particle.

## **6.0 PROCEDURE DETAILS**

### **6.1 CALIBRATION**

Instrument calibrations shall be performed using measuring and test equipment and National Institute of Standards and Technology (NIST) traceable sources. Calibrations will be performed at an accredited calibration facility. Calibration will be performed in accordance with the equipment manufacturers' manuals or a subcontractor's Tt-approved procedure. Properly calibrated instruments shall be marked with a calibration sticker and include an accompanying calibration certificate.

Calibration shall be performed annually or on a schedule consistent with the manufacturer's recommendation if more restrictive. In addition to the routine frequency of performance, calibration shall be performed under the following conditions:

- Prior to placing a new instrument into service.
- After any major repair or alteration to the instrument or detector.

### **6.2 GENERAL CONSIDERATIONS**

Determination of instrument background, chi-square testing and instrument efficiency should be conducted in a controlled environment. This typically will consist of a secured office or lab area located in a non-impacted area and which is known to be free of contamination. Testing jigs or apparatus may be employed as necessary to ensure that consistent, reproducible geometries are used, particularly during repeated measurements.

Table 1 gives suggested geometries to use for the most common instrument types to be used for background and source check measurements. Alternate geometries can be used provided that they are more appropriate for the intended usage of the instrument.

TABLE 1

**SUGGESTED GEOMETRIES FOR BACKGROUND MEASUREMENTS  
AND SOURCE CHECKS**

Measurement	Instrument/Detector Combinations	Probe Location
Exposure Rate	Ludlum Model 19 MicroR Meter or equivalent with integral NaI 1"x1" detector	contact <sup>a</sup>
Gamma	Ludlum Model 2221, 2350-1 or 2360 with Ludlum Model 44-10 or equivalent detector	4 inches above ground surface/source
Beta/Gamma	Ludlum Model 3 portable survey meter with Ludlum Model 44-9 G-M probe or equivalent	¼ inch above ground surface/source
Alpha/Beta	Ludlum Model 2221, 2360 or equivalent portable survey meter with Ludlum Model 43-37, 43-68, 43-89 or equivalent detector	¼ inch from surface/source

**Notes:**

- <sup>a</sup> Field readings with exposure rate instruments are conducted at 1 meter per the Work Plan; background determination, chi-square test and operational checks are typically performed at a more convenient distance. Geometry should be documented as appropriate on the relevant data forms and logs.

G-M – Geiger-Muller

**6.3 DETERMINATION OF INSTRUMENT BACKGROUND**

The determination of an instrument specific background is an optional procedure which may be employed at discretion of the subcontractor. There is no regulatory requirement that necessitates the determination of background for each instrument. Instrument background determination is typically performed in a controlled environment and usually consists of a series of repeated background measurements that are statistically analyzed to obtain an expected range of valid background values. The established instrument background range can be used as a means of performing daily operation checks.

Instrument background determinations, when necessary, are considered valid for as long as the instrument has been properly maintained per the requirements of this procedure. If instrument backgrounds are required, a new background determination should be performed following each calibration.

When determining instrument background, the appropriate approved subcontractor's procedures shall be followed; however, any specific instructions for background determination in governing work-specific documents shall have precedence.

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When required, background determinations will be documented on an approved subcontractor form or as specified in the work-specific procedures. The form should include the following information at a minimum:

- Identification information (i.e. model and serial numbers) for the instrument and detector
- Conditions used for determination (geometry, radiation type, operating voltage, etc.)
- Date and time of determination
- Identification and signature or initials of technician
- Identification and signature of reviewer (typically the SS)

The end result of a background determination should be to obtain an acceptance range for subsequent background checks.

#### **6.4 CHI-SQUARE TEST**

When chi-square tests are required by work-specific documents, the appropriate approved subcontractor's procedures shall be followed; however, any specific instructions for chi-square testing in governing work specific documents shall have precedence. When required, chi-square tests shall be performed annually ( $\pm 15$  days), following calibration, or if there is reason to suspect that the instrument calibration may no longer be valid (i.e. inability to obtain a valid range of chi-square values).

Chi-square tests shall be performed with NIST traceable sources with isotopic content appropriate to the detector being evaluated and the anticipated contaminants in the survey area. The source should be of sufficient activity to yield a counting rate of 1000 to 50,000 counts per minute (cpm).

When required, chi-squared tests should be documented on an approved subcontractor form or as specified in the work-specific documents. The form should include the following information at a minimum:

- Identification information (i.e. model and serial numbers) for the instrument and detector
- Conditions used for the test (geometry, radiation type, operating voltage, etc.)
- Source ID number
- Date and time of determination
- Identification and signature or initials of technician

- Identification and signature of reviewer (typically the SS)

The chi-square test procedure will produce a chi-squared value ( $\chi^2$ ) which should be between 10.11 and 30.14. Failure to obtain a chi-squared value in this range indicates a problem with either the instrument or the methodology used to perform the chi-square test and requires further investigation. The SS should be notified of the failure to assist in planning a course of action.

## 6.5 INSTRUMENT EFFICIENCY FOR PORTABLE INSTRUMENTS

The instrument efficiency ( $\varepsilon_i$ ) is the ratio between the net count rate (in cpm) of the instrument and the surface emission rate of the efficiency check source for a specified geometry. The surface emission rate is the  $2\pi$  particle fluence that is affected by both the attenuation and backscatter of the radiation emitted from the efficiency check source.

The following equation is used to calculate the instrument efficiency in counts per particle:

$$\varepsilon_i = \frac{R_{S+B} - R_B}{q_{2\pi} \left( \frac{W_A}{S_A} \right)}$$

Where,

- $R_{S+B}$  = the gross count rate of the efficiency check source, measured in cpm
- $R_B$  = the background count rate in cpm
- $q_{2\pi}$  = the  $2\pi$  surface emission rate of the calibration source (NIST traceable)
- $W_A$  = the active area of the probe window in square centimeters ( $\text{cm}^2$ )
- $S_A$  = the area of the source in  $\text{cm}^2$

**Note:** This equation assumes that the dimensions of the efficiency check source are sufficient to cover the window of the instrument detector. If the dimensions of the efficiency check source are smaller than the detector's window, set  $W_A$  equal to the dimensions of the efficiency source (i.e., set the quotient of  $W_A$  and  $S_A$  equal to 1).

Instrument efficiency shall be determined for all instruments and radiation and contamination survey meters that are to be used for alpha and beta surveys prior to use for field operations. Instrument efficiency is dependent upon energy of the incident radiation. Multiple energy-specific instrument efficiencies may be determined when isotopes with significantly varying energies are analyzed.

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The procedures in the relevant approved subcontractor's procedures shall be followed to determine the instrument efficiency for those instruments for which it is required. In instances where governing work-specific documents specify a means or expanded scope of inclusion for instrument efficiency determination, they shall have precedence.

All instrument efficiency determinations should be documented on an approved subcontractor form or as specified in the work-specific documents. The form should include the following information at a minimum:

- Identification information (i.e. model and serial numbers) for the instrument and detector
- Conditions used for determination (geometry, radiation type, operating voltage, etc.)
- Source-specific information (ID number, surface emission rate, area),
- Detector window area
- Date and time of determination
- Identification and signature or initials of technician
- Identification and signature of reviewer (typically the SS)

The resulting instrument efficiency should be reported in units of counts per particle.

## **6.6 OPERATION CHECK**

An operation check for each instrument should be performed at the beginning of each work day that a particular instrument is used. The operations check should include the following checks at a minimum:

- Check that instrument calibration is still valid (date on sticker not yet passed)
- Check the instrument (including the probe) for physical defects (knobs, displays, cables, connectors, mylar windows, backlights, speakers, etc.)
- Check of instrument battery (per manufacturers' instructions)
- Source check (should give consistently reproducible results with same source)

Failure of any of the above checks shall result in the instrument being removed from active service until the condition can be addressed. The SS should be notified of any instrument failing an operations check for reasons other than failure of a battery check. In cases of battery check failure, the battery should be replaced and the check repeated.

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The specified checks should each be performed every day and documented on a new line of the check log. A separate check log shall be maintained for each instrument. The check log shall contain the following information at a minimum:

- Identification information (i.e., model and serial numbers) for the instrument and detector
- Conditions used for the check (geometry, radiation type, etc.)
- Source ID number
- Verification of current calibration
- Verification of physical condition
- Verification of battery check
- Verification that source check is in acceptance range
- Date of operational check
- Signature or initials of technician
- Identification and signature of reviewer (typically the SS)

Of the required information given above, only the verifications, date and signature or initials need to be completed on a daily basis. The remaining information can be completed once and kept in the check log with the additional pages for daily checks, provided that none of the information changes. If the information changes, then a new check log should be started.

## **6.7 MAINTENANCE**

Instruments shall be stored in areas, which prevent damage by movement, accumulation of moisture or dust. Detector covers shall be used for storage when practical.

Instrument maintenance (except external adjustments and cable or mylar window replacements) shall be performed by the manufacturer, approved vendor, or qualified personnel.

## **7.0 RECORDS**

Records that result from this procedure may include forms that document background determinations, chi-square tests, instrument efficiency, instrument calibration and check logs. Record forms shall be obtained from approved subcontractor procedures or specified in work-specific procedures.

## **8.0 REFERENCES**

None

## **9.0 ATTACHMENTS**

None.

**Standard Operating Procedure**  
**AIR SAMPLING AND SAMPLE ANALYSIS**

**SOP 008**

**Revision 0**

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3/16/2012

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3/16/2012

Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
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## 1.0 PURPOSE

This procedure will be used by Tetra Tech (Tt) personnel and its subcontractors to perform air sampling and document the results. Results will be used to determine what respiratory protection, if any, is required for the work area.

Air sample analysis will be performed at a radiological laboratory, by trained personnel using approved procedures specific to that laboratory's alpha and beta radiation counting equipment. Further discussion of sample analysis is not within the scope of this procedure.

## 2.0 SCOPE

This procedure will be used for all Tt and subcontractor radiological air sampling activities, regardless of the organization performing the work. Results will be used to determine respiratory protection requirements, and assign dose to workers from inhalation and/or ingestion when necessary.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for ensuring that the conditions of this procedure are complied with during all project operations including periodic reviews of adherence to the requirements of this procedure, ensuring that Radiological Control Technicians (RCTs) are qualified by training and experience to perform the requirements of this procedure, and conducting reviews of air sample data to verify effectiveness of engineering controls and the respirator program.

**Site Supervisor** – The Site Supervisor (SS) shall be responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible to ensure that RCTs implement and use this procedure. The SS will ensure personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technician** – The RCT shall be responsible for the performance of the requirements of this procedure and documentation of work performed. The RCT shall ensure compliance with this and any other referenced procedure.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Airborne Radioactivity Area** – A room, enclosure, or area in which airborne radioactive material, dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases, exist in concentrations:

- In excess of the derived air concentrations (DACs) specified in the Code of Federal Regulations (CFR), Title 10 Part 20, Appendix B; or
- To such a degree that an individual present in the area without respiratory protection could exceed, during the hours that the individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-HR.

**Annual Limit on Intake (ALI)** – The annual limit on intake (ALI) is the derived limit for the quantity of radioactive material taken into the body of a worker by inhalation or ingestion in a year.

**Breathing Zone** – That region adjacent to the worker's mouth and nostrils from which air is drawn into the lungs while he/she performs his/her assigned work. Air taken from this region will represent the air the worker is breathing while he/she works. The samples collected to assess breathing zone concentrations are normally collected from an area within 12 inches of the face.

**Derived Air Concentration (DAC)** – DAC is the concentration of a given radionuclide (as specified in 10 CFR 20, Appendix B) in air which, if breathed by the "reference man" for a working year (40 hours per week for 50 weeks) under the conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one ALI.

**DAC-HR** – The product of the concentration of radioactive material in air (expressed as a multiple of the DAC for each nuclide) and the time of exposure to that nuclide, in hours. Two-thousand DAC-HRs represents one ALI.

**Grab Sample** – A random, single sample taken over a short period of time (dependent upon flow rate) and based upon the minimum volume required.

**High-volume Air Sample** – Air sample taken at an air flow rate of 10 cubic feet per minute (cfm) [283.2 liters per minute (lpm)] to 30 cfm (849.6 lpm).

**Lapel Sampler** – A battery-operated portable air sampler with a sample collector fastened near the breathing zone.

**Low-volume Air Sample** – Air sample taken at an air flow rate of 1 cfm (28.32 lpm) to 5 cfm (141.6 lpm).

**Particle** – An aggregate of molecules forming a solid or liquid ranging in size from a few molecular diameters to some tenths of millimeters (several hundred microns).

**Representative** – Having the same quality and characteristics of the entire volume from which a sample is drawn.

**Sample** – A representative portion of an atmosphere of interest, or one or more separated constituents from a representative portion of an atmosphere.

## 6.0 PROCEDURE DETAILS

Air samples will be taken in areas with the potential to exceed ten (10) percent of the DAC for any radionuclide.

Ambient air monitoring equipment shall be placed in locations representative of the airborne contamination in the work location.

Data obtained from air monitoring shall be used for assessing the control of airborne radioactivity in the workplace and to evaluate the dose equivalent to radiation workers from internal sources.

Process or other engineering controls (e.g., containment or ventilation) shall be used, to the extent practicable, to control the concentration of radioactive material in air.

Air samplers shall be operated in accordance with the manufacturers' operation and calibration procedures.

Filters of different air samples shall be placed in a separate envelope, polybag, or other suitable container to ensure that there is no possibility of cross-contamination.

During collection and handling of air samples, caution must be used to prevent the samples from being contaminated by other sources of radioactive material.

## 6.1 PRECAUTIONS

Avoid unnecessary contamination of air sampling equipment through the use of plastic coverings and care in handling. Do not cover the air intakes or exhausts on air samplers.

Avoid unnecessary exposure when conducting air monitoring surveys by using as low as reasonably achievable (ALARA) practices.

Air samplers used in confined spaces may ignite explosive gases. Extreme care shall be exercised, including prior sampling of the atmosphere for explosive gas and oxygen content.

Samples should be taken in such a manner as not to contaminate the sample filter with materials that are not airborne or by sucking up loose contamination from surfaces near the sampling head. Caution should be used to minimize producing airborne material by the exhaust of the sampler.

When air sample results exceed 10 percent of the DAC value, report this information to the SPM immediately. Also, consideration should be given to isotopic analysis and area access restriction/posting in accordance with SOP 010, *Radiological Restricted Areas-Posting and Access Control*.

## 6.2 TYPE OF AIR SAMPLES

### 6.2.1 GENERAL AREA AIR SAMPLES

General area air samples provide data representative of the work area for determining if the area should be controlled as an airborne radioactivity area. Samples are normally taken over a short period of time ranging from an hour up to one or more days. This type of sample is:

- Taken on a routine basis at predetermined times and locations, as specified by the Radiation Work Permit (RWP), Task-specific Plan (TSP), or other work document
- Uses a low-volume air sampler
- Consists of a minimum of 100 cubic feet (ft<sup>3</sup>) (2,832 liters) of air passed through the sample filter

- Collected at between 3 and 6 feet above the floor level, in the vicinity of the workers performing the fieldwork
- Analyzed for alpha and beta activity at the on-site radiological counting laboratory

### 6.2.2 GRAB SAMPLES

Grab air samples are taken to evaluate the concentration of airborne radioactive radionuclides during the relatively short sampling period. This type of sample is useful for estimating the instantaneous or peak concentration of airborne contamination. This type of sample is:

- Taken as needed during radiological work coverage at the discretion of the RCT, or as directed by the SPM or SS
- Uses a high-volume air sampler
- Consists of a minimum of 100 ft<sup>3</sup> (2,832 liters) of air passed through the sample filter
- Collected in the vicinity of the workers performing the fieldwork
- Analyzed for alpha and beta activity at the on-site radiological counting laboratory

### 6.2.3 BREATHING ZONE AIR SAMPLES

Breathing zone air samples provide data representative of the concentration of airborne radioactive material that a worker would be breathing during a particular task. This type of sample:

- Is used during the work activities with widely varying airborne contamination concentrations across the work area
- Uses a small portable air sampler with sample head attached on the worker's collar
- The sample head is usually positioned within 12 inches of the worker's face
- Consists of a minimum of 50 ft<sup>3</sup> (1,416 liters) of air passed through the sample filter
- Is analyzed for alpha and beta activity at the on-site radiological counting laboratory

## 6.3 AIR SAMPLING PROCEDURES

### 6.3.1 GENERAL

Sample types, number, locations and volumes will be collected as specified in an RWP, TSP or other work document.

Samples will be surveyed with a portable alpha/beta survey meter before placing in envelope or baggie. If the survey indicates the presence of contamination that exceeds background, appropriate steps will be taken to determine source of contamination and secure the area.

Samples will be sent to the on-site laboratory to be analyzed, as a minimum, for gross alpha and beta-gamma and determination (if any) of the DAC.

If sample analysis indicates airborne contamination, which exceed 10 percent of a DAC, appropriate steps will be taken to determine source of contamination and secure the area, notify the SPM and PHP. The PHP will notify the PRSO and Radiological Affairs Support Office (RASO) upon validation of the air sample analysis.

The Air Sample Identification Record (Attachment 1) and Personal Air Monitoring Log (Attachment 2) provide examples of air sampling record sheets. Equivalent or electronic forms, which provide at a minimum the information on these forms, may be used.

Air samples will be preserved and archived after analysis.

### 6.3.2 GENERAL AREA AIR SAMPLING

1. Determine the requirements for air sampling prior to initiating any work activities. This may be done by reviewing the Work Plan, RWP, discussion with the PHP, SPM, SS, and / or workers assigned to the task.
2. Test the functionality of the air sampling equipment prior to entering the work area. Check for current dates on calibration tags and recent calibration of the sampler flow meter. Any equipment not functioning properly, or with calibrations out of date will not be used. Notify the SPM or SS of any equipment that does not function properly.
3. Gather essential supplies before entering the work area. This may include:
  - Extension cords
  - Air sample filters
  - Tongs (if necessary)
  - Additional gloves

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- Air sample envelopes
  - Pen or marker
  - Backup air sample equipment
4. Record the following information on the air sample envelope:
    - Sample identification number
    - Date
    - Location
    - Air sampler identification number
    - Start time
  5. Place the air sampler on a stable surface 3 to 6 feet from the ground, in the vicinity of the workers performing the field activities.
  6. Place an unused sample filter into the sample holder using care not to contaminate the filter with material on the tongs or gloves used to hold the filter while placing it into the holder. If the sampler has been in the contaminated area for some time, it is good practice to clean any visible debris or dust from around the sampler filter holder housing before placing the unused filter into the holder.
  7. Operate the air sampler for the predetermined time. Verify the sampler flow rate, if a flow meter is provided on the sampler. Record any deviation from the predetermined flow rate.
  8. If not provided with an automatic shut-off timer, turn the air sampler off as soon as practical after the predetermined sampling time has elapsed.
  9. Prior to removing the sample from the holder, survey the sample using a hand-held alpha and beta contamination survey meter. Note the activity observed on the outside of the sample envelope.
  10. If the sample survey indicates the presence of radioactive contamination and the area is not already controlled as an airborne radiation area, stop work, notify the SPM, and implement appropriate controls, including postings. Record sample information on the sample envelope, place the sample in the envelope and immediately send to the onsite laboratory for immediate analysis and percent DAC determination.
  11. Using caution not to knock debris or dust from the sample filter holder housing onto the air sample, remove the air sample from the holder using clean gloved hands or clean tongs.
  12. Place the sample into the sample envelope using caution not to scrape or remove contamination from the surface of the sample.
  13. Record the following information on the air sample envelope:
    - Stop time

- Sample volume
  - Sample pump flow rate
14. Send the sample to the on-site counting laboratory for analysis and percent DAC determination.
  15. On Attachment 1, Air Sample Identification Record (or equivalent including electronic), note the sample analysis information provided by the laboratory as soon as the data is available, including:
    - Alpha count results [microCuries per milliliters ( $\mu\text{Ci/mL}$ )]
    - Beta count results ( $\mu\text{Ci/mL}$ )
    - Percent DAC
  16. Complete Attachment 1 by transcribing the information from the sample envelope to Attachment 1 and initialing.
  17. Report any higher than normal, higher than expected, greater than 10 percent of the DAC, or trending upward results to the PHP and SPM immediately.

### 6.3.3 BREATHING ZONE AIR SAMPLING

The following steps will be taken for breathing zone air sampling:

1. Determine the requirements for breathing zone air sampling prior to initiating any work activities. This may be done by reviewing the Work Plan, RWP, discussion with the PHP, SPM, SS, and / or workers assigned to the task.
2. Assemble the individual breathing zone air sampler sets. Make sure that all hoses are firmly seated in the hose connectors found on the sample head and sample pump. Make sure that the sample head is not cracked or damaged in any way. Set any damaged or unusable equipment aside and notify the SPM and PHP.
3. Note the relative size of the individual to whom the sampler will be issued. It may be necessary to replace the standard length belt with a longer belt, or chain two belts together to achieve the required length. Make sure that the belt buckle is not damaged and will function properly to restrain the sampler around the worker. Set any damaged or unusable equipment aside and notify the SPM and PHP.

4. Test the functionality of the air sampling equipment prior to entering the work area. Check for current dates on calibration tags and recent calibration of the sampler flow meter. Any equipment not functioning properly, or with calibrations out of date will not be used. Notify the SPM of any equipment that does not function properly.

**Note:** Only use a sample pump containing a battery that is known to be fully charged.

5. Insert a new, unused sample filter paper into the sample head and tighten the sample head. Take care not to damage the filter paper or the sample head during this operation.

6. Prior to issuing any equipment to a worker, instruct the worker to:

- Refrain from touching or tampering with the pump or the sample head;
- Leave the work area if the sampler fails and note the stop time;
- Contact the RCT for assistance when leaving the work area and at completion of work.

7. Prior to issuing any equipment to a worker, enter the following information on Attachment 2, Personal Air Monitoring Log:

- Wearers' Name
- Wearers' social security number
- Sampler ID number
- Date

8. Attach the personal breathing zone air sampler to the worker. Make sure that the belt is tight, but not uncomfortable.

9. Attach the sample head to the worker. Make sure that the sample head is clipped securely to the worker's lapel or other piece of clothing close to the worker's face. Make sure that opening in the end of the sample head is unobstructed.

10. Check the hose connecting the sample head to the sample pump. Make sure that the hose is not kinked, crimped, or folded. Make sure that the hose is not in a position where it may become kinked, crimped, or folded during work. Make sure that it will not interfere with routine work. If any of these conditions are found, reorient the hose. It may be necessary to find alternate places to position the sample head or sample pump so the hose is unobstructed.

11. Upon arrival at the work location, turn the pump ON. Note the START TIME and flow rate on Attachment 2, Personal Air Monitoring Log.

**Note:** Make sure to note whether flow rate is in units of cfm or lpm.

12. Every time a worker leaves the work area, turn the sample pump OFF and note the stop time. Upon re-entering the work area, turn the sample pump back ON and make a new notation of the re-start time.

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**Air Sampling and Sample Analysis**

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13. At the end of the sampling period (end of the task, or end of the shift), turn the pump OFF and note the stop time on Attachment 2, Personal Air Monitoring Log.
14. Calculate the total time that the sample pump was operating by adding together the operating periods of time.
15. Calculate the total sample volume by multiplying the operating time by sampler flow rate. The result may be in units of cfm or lpm.
16. Record the total sample volume on Attachment 2, Personal Air Monitoring Log. Note the appropriate units (cfm or lpm) on Attachment 2, Personal Air Monitoring Log.
17. Select a clean, unused sample envelope. Label the envelope with the following information:
  - Sample ID number
  - Date
  - Location
  - Worker name
  - Total sample volume (use the appropriate units – cfm or lpm)
18. Open the sample holder using caution not to remove or add to the contamination on the sample.
19. Prior to removing the sample from the holder, survey the sample using a hand-held alpha and beta contamination survey meter. Note the activity observed on the outside of the sample envelope.
20. If the sample survey indicates the presence of radioactive contamination, and the area is not already controlled as an airborne radiation area, stop work, notify the SPM, and implement appropriate controls, including postings.
21. Using caution not to knock debris or dust from the sample filter holder housing onto the air sample, remove the air sample from the holder using clean gloved hands or clean tongs.
22. Place the sample into the sample envelope using caution not to scrape or remove contamination from the surface of the sample.
23. Confirm that the information on the sample envelope matches the information in Attachment 2, Personal Air Monitoring Log.
24. Immediately send the sample to the counting laboratory for analysis and percent DAC determination.
25. On Attachment 2, Personal Air Monitoring Log, note the sample analysis information provided by the laboratory as soon as the data is available, including:

**Air Sampling and Sample Analysis**

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- Alpha count results ( $\mu\text{Ci/ml}$ )
- Beta count results ( $\mu\text{Ci/ml}$ )
- Percent DAC

26. Complete the Attachment 2, Personal Air Monitoring Log.

27. Report any higher than normal, higher than expected, or trending upward results to the PHP and SPM immediately.

**6.3.4 DOCUMENTATION**

Air samples shall be documented using either an Air Sample Identification Record or Personal Air Monitoring Log (or equivalent).

**7.0 REFERENCES**

<i>Number</i>	<i>Title</i>
SOP 010	<i>Radiologically Restricted Areas - Posting and Access Control</i>

**8.0 ATTACHMENTS**

Attachment 1, Air Sample Identification Record

Attachment 2, Personal Air Monitoring Log

## Air Sampling and Sample Analysis

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## ATTACHMENT 1

## AIR SAMPLE IDENTIFICATION RECORD

Project/Location: \_\_\_\_\_

Page \_\_\_\_ of \_\_\_\_

Sample ID	Date	Location	Start Time	Stop Time	Air Sampler ID	Sample Volume	Count Results $\alpha$ ( $\mu\text{Ci/ml}$ )	Count Results $\beta$ ( $\mu\text{Ci/ml}$ )	%DAC	Counter ID

DAC      derived air concentration  
 $\mu\text{Ci/ml}$       microcurie per milliliter  
ID      identification number

$\alpha$       alpha  
 $\beta$       beta

## ATTACHMENT 2

## PERSONAL AIR MONITORING LOG

Name of Wearer	SSN#	Sampler ID #	Date	Time On / Time Off	Flow Rate cfm /lpm	Total Volume ft <sup>3</sup> / Liters	Activity $\alpha$ ( $\mu$ Ci/ml)	Activity $\beta$ ( $\mu$ Ci/ml)	Percent DAC

cfm	cubic feet per minute	lpm	liters per minute
DAC	derived air concentration	$\mu$ Ci/ml	microcurie per milliliter
Ft <sup>3</sup>	cubic feet	$\alpha$	alpha
ID	identification number	$\beta$	beta

**Standard Operating Procedure**

**SAMPLING PROCEDURES**  
**FOR RADIOLOGICAL SURVEYS**

**SOP 009**

**Revision 0**

Prepared By:

Lawson Bailey  
Project Health Physicist

3/16/2012

Date

Approved By:

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3/16/2012

Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

This procedure will be used by Tetra Tech (Tt) personnel and its subcontractors to perform swipe sampling and sampling of various types of media including soil, sediment, solid material (such as concrete, brick, porcelain, wood), and water. This procedure also details sample packaging and transporting samples to the laboratory.

## 2.0 SCOPE

This procedure shall be implemented by Tt staff and subcontractor personnel when collecting samples on field projects related to radiological surveys.

## 3.0 MAINTENANCE

The Project Health Physicist is designated as the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** - The Project Health Physicist (PHP) is responsible for updating this procedure as necessary. In addition, the PHP will coordinate with the Site Project Manager (SPM) to ensure that samples are collected in conjunction with this procedure.

**Site Project Manager** – The SPM is responsible for ensuring that the conditions of this procedure are complied with during project sampling operations. The SPM shall ensure, by periodic personal observation, that samples are collected appropriately and chain-of-custody (COC) is controlled as described in this procedure. The SPM will also ensure that Radiological Control Technicians (RCTs) are qualified by training and experience to perform the requirements of this procedure and ensure that personnel under their cognizance observe proper precautions. The SPM will make a copy of this procedure available to the RCTs.

**Site Supervisor** – The Site Supervisor (SS) shall be responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for the control of radioactive material samples; supervision of RCT's

performing the requirements of this procedure, and to ensure that personnel under their cognizance observe proper precautions.

**Radiological Control Technician** – The Radiological Control Technician (RCT) shall be responsible for the performance of the requirements of this procedure and documentation of work performed. The RCT shall ensure compliance with this and any other referenced procedure.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Swipe Samples** – Swipe samples are materials, which after being wiped over a surface, are analyzed to determine the presence of removable radioactivity on the surface area that was wiped.

**Soil Samples** – Soil samples are defined as soil collected for analytical purposes. Soil samples will be collected from the top 15 centimeters (cm) of the surface, unless otherwise noted in the applicable work-planning document [e.g. a Task-specific Plan (TSP), Work Instruction or Work Plan].

**Sediment Samples** – Sediment samples are defined as a collection of clay, silt, sand, and/or gravel deposited by water, wind, or glaciers used for analytical purposes.

**Solid Material Samples** – Solid material samples are defined as pieces of concrete, brick, porcelain, wood, or any other hard material collected for analytical purposes from buildings or surrounding areas. The samples could include accumulations from ventilation systems or drain systems.

**Liquid Samples** – Liquid samples are defined as liquid collected for analytical purposes from sinks, drain piping, sewer systems, rinsate, groundwater, leachate, liquid investigation-derived waste, and low-point accumulation areas inside of buildings, sumps, and excavation pits.

## 6.0 SAMPLING PROCEDURE DETAILS

### 6.1 GENERAL PROCEDURES

Field instruments used for measurements required by this procedure shall be checked with standards and verified to have current calibration.

Anytime this procedure is in effect, the SPM (or qualified designee) should ensure, by periodic personal observation, that samples are appropriately collected and controlled.

Surface scan surveys are to be performed at each location before initiating sampling. This will identify the presence of gross contamination, which will require that samples and equipment be treated as radioactive and handled in accordance with applicable license requirements. Samples will be recorded on COC documentation.

## 6.2 SAMPLING PROCEDURE PROCESS

Sample activities will be recorded in the field logbook as directed by the Sampling and Analysis Plan (SAP). Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting samples at each location.

### 6.2.1 SWIPE SAMPLING

Swipe samples will be obtained in accordance with SOP 006, *Radiation and Contamination Surveys*. Swipe samples will be documented in the sample logbook as applicable. Sample COC records shall be completed in accordance with the SAP.

### 6.2.2 SOIL SAMPLING

Because standard surface soil contamination criteria for radionuclides are applicable to the average concentration in the upper 15 cm of soil, the sampling protocol described here is based on obtaining a sample of this upper 15 cm. Special situations, such as sampling at depths greater than 15 cm, evaluating trends or airborne deposition, determining near-surface contamination profiles, and measuring non-radiological contaminants, may require special sampling procedures. These special situations will be evaluated and incorporated into TSPs as the need arises.

Samples will be collected with a hand-auger, hollow-stem auger, split-spoon sampler, disposable scoop, or equivalent. The soil removed for sampling must be sufficient to yield a sample of sufficient volume for the sample container being used. Soil samples will be collected and handled as follows:

1. Loosen the soil at the selected sampling location to a depth of approximately 15 cm, using a trowel or other digging instrument.
2. Remove large rocks, vegetation and foreign objects. In some cases, however, these objects may be the source of the contamination and may be collected as separate samples for characterization.
3. Place as much soil as practical into a 250-milliliter (mL)-wide mouth plastic bottle or plastic 500-mL Marinelli container.
4. If sample containers are not readily available, samples may be collected in a plastic bag for subsequent transport to the laboratory for sample preparation.
5. Tape the cap of the container in place or seal the ziplock plastic bag.

6. Label the sample container in accordance with the SAP.
7. Document all samples collected in the sample logbook as applicable. Sample COC records shall be completed in accordance with the SAP.
8. Transport samples to the on-site laboratory for analysis as soon as possible after sample collection. Sample packaging and shipment procedures for transporting samples to an off-site laboratory are described in Section 6.3 of this procedure.
9. Clean or decontaminated tools will be used at each sampling location. Sampling tools will be decontaminated as described in the SAP.

### 6.2.3 SEDIMENT SAMPLING

Several methods are available to collect sediment samples. The tools used will be appropriate to the circumstances and may include use of trowels, augers, or other hand tools. Sediment sampling will be conducted as follows:

1. A hand-auger, trowel or similar device will be used to access each sampling location. The sample collection tool will be selected based on physical limitations accessing the sample location.
2. Place as much material as practical into a 250-mL-wide mouth plastic bottle or plastic 500-mL Marinelli container.
3. Follow steps 4 through 9 of Section 6.2.2 to complete sample collection.

### 6.2.4 SOLID MATERIAL SAMPLING

Several methods are available to collect solid material samples. To collect samples, solid materials may need to be broken into smaller pieces. Solid materials will be collected as follows:

1. Break up the material into small enough pieces to fill a 250-mL-wide mouth plastic bottle or plastic 500-mL Marinelli container.
2. Follow steps 4 through 9 of Section 6.2.2 to complete sample collection.

#### 6.2.4.1 Pipe and Drain Line Sampling

Pipe and drain line sampling is conducted to assess residual radioactivity that may be inside of drain lines or materials within sanitary sewer and storm drain systems.

1. Since the type of material found inside drain lines varies, there is no specific method identified to collect these samples. Samples may be collected using a plumber's snake, swabs, scraper, trowel, etc.

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**Sampling Procedures for Radiological Surveys**

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2. As much material as possible should be collected and placed into a 250-mL-wide mouth plastic bottle or plastic 500-mL Marinelli container
3. Follow steps 4 through 9 of Section 6.2.2 to complete sample collection.

**6.2.4.2 Ventilation Sampling**

Ventilation sampling will be performed to identify if the system is impacted and assess the residual radioactivity that may be present.

1. If visible dust is present inside the ventilation system, use a masslin cloth to accumulate the material into a pile. (If no visible dust is present, collect a swipe sample as discussed in SOP 006, *Radiation and Contamination Surveys*.)
2. Using a flat utensil such as a piece of paper or scraper carefully place as much material as possible into a 250-mL-wide mouth plastic bottle or plastic 500-mL Marinelli container.
3. Follow steps 4 through 9 of Section 6.2.2 to complete sample collection.

**6.2.5 WATER SAMPLING**

Water samples will be collected as follows:

1. Collect water using any of the following sampling equipment: disposable bailer, pump, coliwassa-type tube sampler, or equivalent. Care will be taken to avoid collection of bottom sediment or vegetation.
2. Fill completely a 250-mL-wide mouth plastic bottle, plastic 500-mL Marinelli container or two liter plastic bottles.
3. Follow steps 5 through 9 of Section 6.2.2 to complete sample collection.

**6.3 SAMPLE HANDLING AND TRANSPORT****6.3.1 Handling**

Radioactive sample handling includes the field-related considerations connected with the accountability of samples and required surveys.

Radiological surveys will be performed during the collection of samples. Surveys and documentation will be performed in accordance with SOP 006. The number of samples, including required quality samples, will be determined by the project sampling plan. Sample preservatives and hold times are not applicable to the radioactive samples described in this procedure.

**Sampling Procedures for Radiological Surveys**

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Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample will be considered to be in custody if it is:

- In a person's physical possession or view.
- In a secure area with restricted access.
- Placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Chain-of-custody records (COC) provide a record that traces the possession of individual samples from the time they are collected in the field to the time they are accepted at the laboratory. The COC will also be used to document all samples collected and the analysis requested. Information recorded on the chain-of-custody record will include:

- Project name and number
- Sampling location
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample ID numbers
- Date and time of collection
- Number and type of containers filled
- Analysis requested
- Sample designation (grab or composite)
- Signatures of individuals involved in custody transfer, including the date and time of transfer

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**Sampling Procedures for Radiological Surveys**

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- Airbill number and name of the carrier (if applicable)
- Project contact and phone number

The top two copies of the COC (white and pink) will be placed in a re-sealable bag and placed inside the outer container. The yellow copy, as well as the air bill, will be maintained at the project site and the manila copy will be forwarded to the PHP.

### 6.3.2 Packaging and Shipping

Radioactive material (Class 7) has very restrictive packaging requirements in accordance with DOT regulations. 49 CFR lists conditions under which this material is excepted from many requirements ("Excepted Package"). Only samples containing low level radioactive material and radioactive sources used for instrumentation quality checks will require shipping during this project and are classified as Limited Quantity packages. All material AND containers/packages will be evaluated and surveyed to verify this classification. The requirements for "Limited Quantity" excepted packages (49 CFR 172.421) and their shipping container requirements have been condensed and listed below. Since Tt uses Fed Ex for the shipping of all hazardous material, the requirements have been simplified to use with this carrier.


#### Quantity of Material

Radioactive material package must meet the following radiological criteria:

- activity per package is less than limits found in 49 CFR 173.425;
- does not contain more than 2 grams fissile material;
- the radiation level at any point on the external surface of the package does not exceed 0.5 mrem/ hour; and
- the removable surface contamination on the external surface of the package must be less than 220 dpm/100 cm<sup>2</sup> for beta, gamma, and low toxic alpha emitters, and less than 22 dpm/100cm<sup>2</sup> all other alpha emitters.

#### Packaging

The inner package must be double containerized (actual sample container and zip-lock bag) and marked with a "Radioactive Material" label including trefoil with survey results, date, and surveyor's name (see example below).

<p style="text-align: center;"><b>CAUTION</b></p>  <p style="text-align: center;"><b>Radioactive Material</b></p> <p>Description: _____</p> <p>Maximum contamination: _____ dpm/100cm<sup>2</sup></p> <p>Maximum Dose Rate: _____ mrem/hr</p> <p>Surveyed By: _____ Survey Date: _____</p>
---

If the samples contain liquid materials, watertight primary and secondary containers must be leak-proof (i.e. canister, jar). The primary container must not contain more than 1L and have positive closures. Absorbent material must be placed between primary and secondary package in amounts to absorb all liquids in the package.

If the samples contain only solid materials, watertight primary and secondary containers must be sift-proof (i.e. plastic bag, sealed Styrofoam container). Primary container must not contain more than 500g and have positive closures.

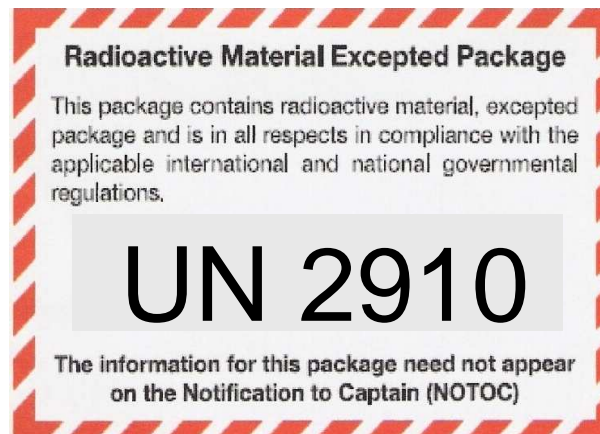
The outer package must

- meet the general design requirements (see below) for hazardous material container the most common and accessible shipping container meeting requirements is a cooler.
- not contain more than 4L total liquids and 4 kg total solid hazardous materials
- be sealed, including any means contents could escape (i.e. cooler with drain spout must be taped)
- have adequate internal filler or cushioning to protect contents
- be secured with strapping tape

## Sampling Procedures for Radiological Surveys

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- have two custody seals tapped across the lid of the container: one seal in the front and one seal in the back, each crossing over the container's opening edge.
- be marked with "Radioactive Material – Excepted Package" and "UN2910" label See example below)



- have legible which are clearly visible and not overlapping onto other sides of the package. If the package is an irregular shape, then labels may be attached as tags.
- have other labels, as appropriate, added to certain packages. Examples include Fragile/Handle with Care labels, "Heavy" labels (typically needed for packages that weigh 70 pounds or more), and oriented arrows (should be placed in the required direction at least on three opposite sides of the package 120° opposed from one another).

Shipping Papers (Air bill)

If package does not contain any other hazardous material or hazardous waste, a "Shipper's Declaration for Dangerous Goods" is **NOT** required. When filling out the air bill for "Special Handling", "Yes – Shipper's Declaration not required" should be checked when asked "Does this shipment contain dangerous goods?"

## 7.0 RECORDS

Sample collection records will include field logbooks and COCs. These records will be completed and maintained in accordance with the SAP.

## 8.0 REFERENCES

<i>Number</i>	<i>Title</i>
SOP 006	<i>Radiation and Contamination Surveys</i>

## 9.0 ATTACHMENTS

None.

**Standard Operating Procedure**  
**RADIOLOGICALLY CONTROLLED AREAS -**  
**POSTING AND ACCESS CONTROL**

**SOP 010**

**Revision 0**

Prepared By:

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3/16/2012

Date

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3/16/2012

Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

The purpose of this procedure is to specify methods and requirements for consistent posting and control of radiologically restricted areas. This procedure is intended to satisfy the posting requirements of 10 Code of Federal Regulations (CFR) 20 (1-92), Standards for Protection Against Radiation.

## 2.0 SCOPE

This procedure identifies the types of postings necessary and requirements to clearly identify radiological conditions in a specific area or location within an area. It also specifies the requirements for access into and egress from radiologically controlled areas. This procedure will be used by Tetra Tech (Tt) personnel and its subcontractors to control entry and egress from radiologically controlled areas (RCAs).

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Project Managers** – The Site Project Manager (SPM) is responsible for ensuring that all personnel are adequately trained to verify the adequacy of area postings and the radiological controls within an area. The SPM is responsible for ensuring that a copy of this procedure is available at the jobsite and that field technicians follow this procedure. The SPM is responsible for installing radiological postings.

**Site Supervisor** – The Site Supervisor (SS) shall be responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for ensuring that Radiological Control Technicians (RCTs) implement and use this procedure. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technicians** – The RCT shall be responsible for the performance of the requirements of this procedure and documentation of work performed. The RCT shall ensure compliance with this and any other referenced procedure.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Airborne Radioactivity Area** – A room, enclosure or area in which radioactive material is dispersed in air in the form of dusts, fumes, particulates, mists, vapors, or gases, and the concentration of the dispersed radioactive materials is in excess of:

- The derived air concentrations (DACs) specified in Table 1, Column 3 of Appendix B, Title 10 Part 20 of CFR.
- Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI).

**Annual Limit on Intake (ALI)** – The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a 1-year period. ALI is the smaller value of intake of a given radionuclide by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 sievert [Sv]) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2 of Appendix B of 10 CFR 20.) One ALI is equivalent to 2,000 DAC-hrs.

**As Low As Reasonably Achievable (ALARA)** – An approach to radiation protection for the control and management of exposure (both individual and collective) to the workforce and the general public; thus ensuring a level of exposure as low as social, technical, economic, practical, and public policy considerations permit. The ALARA program is structured to increase worker awareness of exposure reduction techniques and the associated benefits of that reduction.

**Contaminated Area** – Any area where removable surface contamination levels exceed 20 percent of the contamination limits provided in Table 1 (Attachment 1).

**Derived Air Concentration (DAC)** – The concentration of a given radionuclide in air which, if breathed for a working year of 2,000 hours under conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of Appendix B of 10 CFR 20 (1-92), Standards for Protection Against Radiation.

**Fixed Contamination** –Surface contamination exceeding the contamination limits provided in Table 1 (Attachment 1), that can not be readily removed from a surface by applying light to moderate pressure when wiping with a paper or cloth disk swipe, or masslin.

**Radiation Area** – Any area accessible to personnel in which there exists ionizing radiation at exposure rates such that an individual could receive a deep dose equivalent (DDE) in excess of 2 millirem (mrem) in 1 hour at 30 centimeters (cm) from the radiation source or from any surface that the radiation penetrates.

**Radiation Work Permit (RWP)** – A document generated, in accordance with SOP 002, *Issue and Use of Radiation Work Permits*, to provide specific requirements for radiological activities.

**Radioactive Materials Area (RMA)** – Any designated area where radioactive materials are stored or used. Posting of an RMA is not required if the radioactive material is stored inside a radiation area, contaminated area or airborne radioactivity area.

**Radiologically Controlled Area (RCA)** – An area containing radioactive materials (in excess of the levels provided in Table 1) to which access is controlled to protect individuals from exposure to ionizing radiation.

**Underground Radioactive Materials (URM)** –An underground area that is known to contain radioactive materials such as pipelines, tanks, cribs, covered ponds, covered ditches, catch basins, inactive burial grounds and sites of known, covered spills.

## 6.0 PROCEDURE DETAILS

### 6.1 GENERAL

This procedure will address establishing and posting:

- RCAs
- RMAs
- Radiation areas
- Contaminated areas

- Airborne radioactivity areas
- Underground RMAs

### 6.1.1 PRECAUTIONS

Personnel working in a RCA shall:

- Comply with all radiation protection instructions and postings.
- Refrain from eating, drinking, smoking or chewing while in a RCA.
- Perform jobs or tasks in such a manner that minimizes the creation or spread of contamination.
- Ensure that tools and equipment are surveyed prior to removing the items from a RCA.
- Refrain from loitering in radiation areas.
- Wear dosimetry in a manner required by the RWP.
- Perform a personal contamination survey upon exit from a RCA.
- Immediately report the loss, damage or unexpected exposure of dosimetry to the SPM.
- Notify the SS of any wounds, sores or rashes before entering any area where contamination exists.
- Exit immediately if a wound occurs in a RCA, notify the RCT and seek first aid.
- Follow any additional requirements dictated by the PHP, SPM, SS or RCT.

### 6.1.2 SIGNAGE

All posted areas will be designated an RCA. Additional restricted areas (such as a CA, RA, RMA, ARA) may be posted within an RCA, as necessary, to identify additional precautions that may be required.

Signs identifying radiological hazards shall be posted on all entrances and accessible sides of the barrier surrounding the identified RCA. Signs identifying radiological hazards shall be firmly attached to the barrier or entrances with materials that will withstand the effects of adverse weather and normal use conditions. If signs with the exact wording are not readily available, alternative phrases may be used as long as the same requirements are clearly communicated by the posting. Signs will be identified in English and Spanish.

### 6.1.3 SURVEYS

Radiation and contamination surveys for establishing and maintaining RCAs shall be performed in accordance with SOP 006, *Radiation and Contamination Surveys*.

## 6.2 PROCEDURE PROCESS

### 6.2.1 ESTABLISHING AND POSTING RADIOLOGICALLY CONTROLLED AREAS

RCAs shall be designated by clearly and conspicuously posting all entrances and all other accessible sides of the area with a sign bearing the following:



The sign will also list requirements for entering the RCA. To enter a RCA, a person must meet all posted requirements.

### 6.2.2 POSTING REQUIREMENTS FOR RADIOACTIVE MATERIALS AREAS

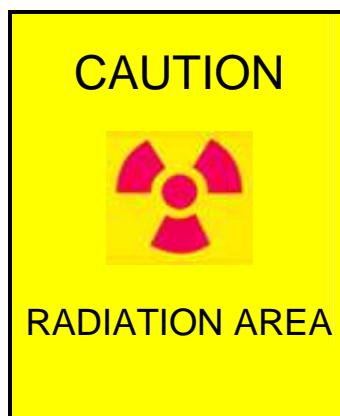
Radiation protection personnel shall post any area or room in which radioactive materials are stored with a sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIALS AREA."



When posting a room, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area containing the radioactive material shall be bounded by signs fastened to stanchions, posts or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction. If signs with these exact words are not readily available, alternative phrases may be used as long as the same requirements are clearly communicated by the posting.

### 6.2.3 ESTABLISHING AND POSTING RADIATION AREAS

Radiation protection personnel shall post radiation areas with signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."



If an entire room or most of a room is at or above the 2 milliroentgen per hour (mR/hr) level, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area at or above the 2 mR/hr level shall be bounded by signs fastened to stanchions, posts or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction. If a posting is placed on a door in a manner that would prevent the posting from being observed if the door is propped open, an additional posting shall be placed in the doorway.

A single entry/exit point shall be established to access the radiation area. Access into radiation areas shall be limited to radiation workers wearing dosimetry that are signed-in on an approved RWP.

#### **6.2.4 ESTABLISHING AND POSTING CONTAMINATED AREAS**

##### **6.2.4.1 Removable Surface Contamination**

Radiation protection personnel shall post any contaminated area with a sign or signs bearing the radiation symbol and the words "CAUTION, CONTAMINATED AREA."



When posting a room, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area containing the contamination shall be bounded by signs fastened to stanchions, posts or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction.

A single entry/exit point shall be established to access the contaminated area. A step-off pad is placed at the entry/exit point that provides a defined boundary between contaminated and non-contaminated areas. Each contaminated area that is to be

entered shall have a step-off pad maintained in an uncontaminated condition located at the access/egress point.

Contaminated areas, which require personnel access on a daily basis, should have a frisking station located as close to the access/egress point as is reasonably possible, taking background radiation levels and work processes into consideration. All personnel exiting a contaminated area shall perform personnel contamination monitoring in accordance with the applicable RWP.

#### **6.2.4.2 Fixed Contamination**

If the area of contamination is within a RCA, the boundaries of the contaminated area will be delineated in such a way to identify it for future characterization.

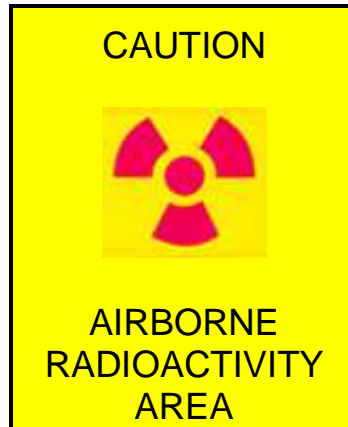
If the area of contamination is not within a RCA, then the area will be posted as a contaminated area, as described in Section 6.2.4.1.

#### **6.2.5 ESTABLISHING AND POSTING AIRBORNE RADIOACTIVITY AREAS**

It policy is to minimize the amount of radioactive materials taken into a worker's body. In order to accomplish this, Airborne Radioactivity Areas are posted at 10 percent DAC, as specified in Table 1, Column 3 of Appendix B of 10 CFR 20. Maintaining the airborne activity below these limits will eliminate any posting requirements.

To verify that the limits for airborne radioactivity are not exceeded, air sampling will be performed continuously during each work activity. The results of the air samples are compared with the limits above to verify that the limits are not exceeded. If the limits are exceeded, immediately contact the SPM or designee.

Radiation protection personnel shall post any Airborne Radioactivity Area or room with a sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA."



When posting a room, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area containing the airborne radioactivity shall be bounded by signs fastened to stanchions, posts or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction.

#### **6.2.6 ESTABLISHING AND POSTING UNDERGROUND RADIOACTIVE MATERIALS AREAS**

The entrance to any area (normally outside areas) shall be posted to indicate the presence of identified underground items that are known to contain radioactive materials such as pipelines, tanks, cribs, covered ponds, covered ditches, catch basins, inactive burial grounds and sites of known, covered, spills.

The entrances to the areas shall be clearly and conspicuously posted:



Underground radioactive material areas shall also be posted “Authorized Personnel, RWP Required for Entry.” If signs with these exact words are not readily available, alternative phrases may be used as long as the same requirements are clearly communicated by the posting.

## 7.0 RECORDS

Documentation generated by the implementation of this procedure shall consist of recording the date and location of any radiologically controlled, radioactive material, radiation, contaminated or airborne radioactivity areas established in the project logbook. Include a sketch of the area and area boundary on survey forms.

## 8.0 REFERENCES

<b><i>Number</i></b>	<b><i>Title</i></b>
SOP 002	<i>Issue and Use of Radiation Work Permits</i>
SOP 006	<i>Radiation and Contamination Surveys</i>
NRC Reg. Guide 1.86	<i>Termination of Operating Licenses for Nuclear Reactors</i>

## 9.0 ATTACHMENTS

Table 1

Table 1

Radionuclides	CAS Number	SURFACES	SOILS <sup>b</sup>	WATER <sup>d</sup>
		Structures, M&E, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	pCi/g <sup>c</sup>	pCi/L
Cesium-137	10045-97-3	5,000	6.6	119
Cobalt-60	10198-40-0	5,000	2.28	100
Plutonium-239	15117-48-3	100	1.38	15
Radium-226	13982-63-3	100	1.0	5 <sup>e</sup>
Strontium-90	10098-97-2	1,000	1.02	8
Thorium-232	7440-29-1	1,000	0.66	15
Tritium (H-3)	10028-17-8	5,000	66	20,000
Uranium-235	7440-61-1	5,000	4.8	30
Uranium-238	7440-61-1	5,000	8.4	30

## Notes:

pCi/g picocurie per gram

pCi/L picocuries per liter

dpm disintegration per minute

- a These limits are based on AEC Regulatory Guide 1.86 (USAEC 1974). Values indicate the measured value above background as determined from the reference area. Limits for removable surface activity are 20 percent of these values.
- b These limits are based on Nuclear Regulatory Commission document NUREG-1727, NMSS Decommissioning Standard Review Plan (NRC 2000), whose limits are deemed in compliance with the 25 mrem/y unrestricted dose limit in 10CFR20.1402. Listed values were developed by scaling the NUREG-1727 values to 15 mrem/y unrestricted dose.
- c Criteria is above background for those radionuclides found in background soils.
- d Release criteria for water have been derived from *Radionuclides Notice of Data Availability Technical Document* (EPA 2000) Table III, which compared the federal drinking water standards from the 1976 and 1991 Maximum Contaminant Levels. This value reflects the most conservative limit.
- e Limit is for total Radium Concentration.

**Standard Operating Procedure**  
**CONTROL OF RADIOACTIVE MATERIAL**

**SOP 011**

**Revision 0**

Prepared By:

Lawson Bailey  
Project Health Physicist

3/16/2012  
Date

Approved By:

Eric J. Alkender  
Project Radiation Safety Officer

3/16/2012  
Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

The purpose of this procedure is to specify methods and requirements for tracking and controlling radioactive material (RAM) collected or generated during survey, characterization and remediation activities by Tetra Tech (Tt) and its subcontractors. Specific details on implementation of unique license requirements (i.e. Nuclear Regulatory Commission (NRC) reporting frequencies and format) are the responsibility of the license holders.

This procedure is not intended to revise or take precedence over existing NRC material handling licenses. Furthermore, the assignment of Tt personnel as cognizant individuals (per Section 4.0 of this procedure) does not in any way remove the onus of compliance from the employees of the actual license holder. Through the use of the guidance in this procedure, Tt and its subcontractors shall meet or exceed the requirements for their respective NRC radioactive materials licenses (RMLs).

## 2.0 SCOPE

This procedure governs control of RAM on site and shall be implemented by Tt staff and subcontractor personnel when handling RAM. The requirements given in this procedure are limited to RAM collected or generated during survey, characterization and remediation activities. Compliance with NRC RML requirements, not included in the scope of this procedure, is the responsibility of the individual license holders.

Procedures for the preparation and labeling of RAM for shipment are beyond the scope of this document. Packaging, labeling, and shipment of RAM shall be conducted in accordance with the requirements of 49 Code of Federal Regulations (CFR) and other applicable regulations.

Radioactive waste will be packaged in an appropriate container. The waste containers will be maintained under Tetra Tech EC's RML, until disposed of via the Navy's Low-level Radioactive Waste program.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP or designee is responsible for updating the base wide radioactive waste inventory (RWI) of RAM waste. The PHP is also responsible for ensuring that subcontractors are implementing this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for ensuring that all personnel assigned the tasks of control and tracking of RAM are familiar with this procedure, adequately trained in the use of this procedure and have access to a copy of this procedure. The SPM is responsible for ensuring that the conditions of this procedure are complied with during all project operations. Additionally, the SPM is responsible for ensuring that Radiological Control Technicians (RCTs) are qualified by training and experience to perform this procedure and for training RCTs in the performance of this procedure. The SPM is also responsible for maintaining an inventory of their samples.

**Site Supervisor** – The Site Supervisor (SS) shall be responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for ensuring that RCTs implement and use this procedure. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technician** – The RCT shall be responsible for the performance of the requirements of this procedure and documentation of work performed. The RCT shall ensure compliance with this and any other referenced procedure.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Container** – Any package or barrier which is used to enclose RAM so that it can be easily handled and contained. Examples of containers include drums, roll-off boxes, conex boxes, fiber, metal, wooden or cardboard boxes, plastic or glass jars, metal cans, bags (ziplock or open top), plastic sheeting or any other package that meets the requirements of this definition.

**Control** - In relation to handling of RAM, control is defined as having physical custody, being in the immediate vicinity of, or in line-of sight of the RAM. Control also refers to being responsible for the securing of RAM to prevent unauthorized access.

**Mixed Waste** – Waste that contains a hazardous waste component and a RAM component.

**Radioactive Material (RAM)** – RAM is defined as any material (e.g. soil, demolition debris, etc.), solid samples or swipes, or equipment (tools, instruments, etc.), that has a radioactive component (fixed or removable) at or above the levels specified in Table 6-1.

**Radioactive Materials Area (RMA)** – Any designated area where Ram is stored or used. Posting of an RMA is not required if the RAM is stored inside a posted, radiation area, contaminated area or airborne radioactivity area.

**Radiologically Controlled Area (RCA)** – An area containing RAM (in excess of the levels provided in Table 6-1) to which access is controlled to protect individuals from exposure to ionizing radiation.

**Samples** – Aliquots (portions) of material deposited on or placed within a container for the purposes of transferring and performing a quantitative or qualitative analysis of that material.

## 6.0 PROCEDURE DETAILS

### 6.1 CLASSIFICATION AND IDENTIFICATION OF RADIOACTIVE MATERIAL

#### 6.1.1 RADIOACTIVE MATERIAL LIMITS

Table 6-1 identifies the limits of contamination and/or activity for defining RAM.

**TABLE 6-1**  
**CONTAMINATION LIMITS TABLE**

Radionuclides	CAS Number	SURFACES	SOILS <sup>b</sup>	WATER <sup>d</sup>
		Structures, M&E, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	pCi/g <sup>c</sup>	pCi/L
Cesium-137	10045-97-3	5,000	6.6	119
Cobalt-60	10198-40-0	5,000	2.28	100
Plutonium-239	15117-48-3	100	1.38	15
Radium-226	13982-63-3	100	1.0	5 <sup>e</sup>
Strontium-90	10098-97-2	1,000	1.02	8
Thorium-232	7440-29-1	1,000	0.66	15
Tritium (H-3)	10028-17-8	5,000	66	20,000
Uranium-235	7440-61-1	5,000	4.8	30
Uranium-238	7440-61-1	5,000	8.4	30

Notes:

pCi/g picocurie per gram

pCi/L picocuries per liter

dpm disintegration per minute

**Control of Radioactive Material**

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- a These limits are based on AEC Regulatory Guide 1.86 (USAEC 1974). Values indicate the measured value above background as determined from the reference area. Limits for removable surface activity are 20 percent of these values.
- b These limits are based on Nuclear Regulatory Commission document NUREG-1727, NMSS Decommissioning Standard Review Plan (NRC 2000), whose limits are deemed in compliance with the 25 mrem/y unrestricted dose limit in 10CFR20.1402. Listed values were developed by scaling the NUREG-1727 values to 15 mrem/y unrestricted dose.
- c Criteria is above background for those radionuclides found in background soils.
- d Release criteria for water have been derived from *Radionuclides Notice of Data Availability Technical Document* (EPA 2000) Table III, which compared the federal drinking water standards from the 1976 and 1991 Maximum Contaminant Levels. This value reflects the most conservative limit.
- e Limit is for total Radium Concentration.

**6.1.2 IDENTIFICATION OF RADIOACTIVE MATERIAL**

Determination of whether or not to classify material or equipment as RAM waste is accomplished by surveying and/or sampling the material or equipment. In the absence of survey data, material originating from impacted areas or RCAs shall be classified as RAM and handled accordingly until proven otherwise by instrument survey or laboratory analysis.

**6.1.3 MIXED WASTE**

Mixed waste may be encountered or generated during remediation or decontamination activities. If the radiological and chemical components in the waste can be easily separated by physical means, this shall be done to allow for each component to be handled separately. Work shall be conducted to minimize mixed waste. Chemicals used for chemical decontamination activities shall be selected to minimize the creation of mixed waste. When it is impossible to segregate hazardous and radioactive components of materials or equipment designated for disposal, then the item(s) must be handled as a mixed waste. Applicable precautions and guidance for handling both RAM and hazardous material must be used for mixed wastes.

**6.2 STORAGE OF RADIOACTIVE MATERIAL**

Radioactive material must be stored in a posted area as specified below to communicate the material hazard present to personnel that may encounter the material. Posting will be done in accordance with SOP 010, *Radiologically Restricted Areas – Posting and Access Control*. RAM waste shall be containerized, whenever possible, or otherwise protected and stored in pre-authorized areas determined concurrently by the Radiological Affairs Support Office (RASO) and the Remedial Project Manager. Control must be maintained over all RAM to minimize personnel exposure and the spread of contamination. Requirements for containerizing, posting, and control of RAM are given below.

**6.2.1 CONTAINERIZING**

To the greatest extent possible, RAM waste should be containerized for storage. To facilitate containerization, equipment that can be disassembled should be broken down into the smallest number of components practical. Sharp edges or projections should

be blunted, taped or otherwise secured to ensure that the package will maintain integrity during subsequent handling operations.

If object size does not allow for disassembly and containerization is not possible, then a plastic covering can be used to minimize the potential for the spread of contamination.

For bulk items, such as soil stockpiles, where containerization is not practicable, the materials will be placed on an impervious material and covered to prevent the spread of the material.

Items that exceed 100 times the limits in Table 6-1 should be packaged such that two barriers exist (i.e., double-wrapped or bagged inside a rigid container).

### 6.2.2 POSTING

Posting will be done in accordance SOP 010, *Radiologically Restricted Areas - Posting and Access Control*

RAM waste that is stored in a building requires that the entrances to the building be posted as a RCA, and a cordoned off area within the building posted as the RMA. If RAM waste is stored in stockpiles or in large containers that are stored outdoors, the stockpiles or containers shall be located within an RCA. The immediate area around the stockpile or containers will be cordoned off and posted as an RMA.

### 6.2.3 CONTROL

The control of RAM shall be performed in accordance with the provisions of 10 CFR 20, Standards for Protection Against Radiation; SOP 010, *Radiologically Restricted Areas – Posting and Access Control*, SOP 012, *Release of Materials and Equipment from Radiologically Controlled Areas*, SOP 016, *Decontamination of Equipment, Materials, and Tools*.

Radioactive material should be consolidated in common RMAs to the greatest extent possible to simplify the implementation of adequate materials control. Control of RMAs will include security measures (i.e., locks, fencing, packaging, etc.) to preclude unauthorized access to or removal of RAM. Access shall also be controlled to prevent non-radiation workers from gaining entry to RMAs. RMAs will be inspected at least once a week by an RCT. RCTs shall note the physical status of RMAs noting:

- Locked/secure status
- Labeling/posting
- Condition of containers

### **6.3 RADIOACTIVE WASTE INVENTORY MANAGEMENT**

A radioactive waste inventory (RWI) program will be used to track RAM waste generated during survey and remediation activities. The program includes the provision for regular inventory checks, as well as weekly reporting of inventory to RASO. The specific requirements for inventory management are given in the following sections.

#### **6.3.1 CONTAINER/STOCKPILE INVENTORY**

A running inventory of materials in a container will be kept on the container. Stockpile inventories will be kept in the Tt site trailer. Inventories of material in a container or stockpile will be kept on the Stockpile/Container Inventory Log Sheet, or equivalent, (Attachment 1). The log sheet will be updated as material is added to containers or stockpiles.

#### **6.3.2 REPORTING**

Tt shall receive weekly inventory updates from its subcontractors updating the amount of RAM waste maintained by them. These reports should indicate that the location and status for all RAM waste has been verified and accounted for. In addition, the reports will include the following information for new RAM waste:

- Point of origin
- Storage location
- Removal Date
- Waste description
- Isotope and activity (If known)
- Other hazardous constituents (If known)
- Quantity or volume
- Waste packaging dates
- Any additional comments

Tt will maintain a master RWI of all RAM waste. The RWI for the project will be updated weekly by the PHP or designee. The PHP or designee will produce an inventory report weekly, using the Radioactive Waste form (Attachment 2) for distribution to RASO.

### **6.4 DISPOSITION OF RADIOACTIVE MATERIAL**

Disposition of RAM collected during remediation, surveys, or generated through site activities will either be disposal or reduction in volume by decontamination. The considerations for these two activities are discussed below.

#### 6.4.1 DECONTAMINATION

In some instances, it may be possible to reduce the volume of RAM by decontaminating items contaminated with RAM to levels at which the item no longer needs to be classified as RAM. The guidance for determining if decontamination is appropriate and for actually performing decontamination is given in SOP 016, *Decontamination of Equipment, Material and Tools*.

Any former RAM that has been decontaminated to levels below those requiring classification as RAM shall have any RAM labels removed or otherwise defaced such that the wording and radiation symbol are no longer legible. Additionally, the status of any inventoried RAM that has been decontaminated shall be updated on the associated data sheets and in the RMI to indicate that it is no longer an actively tracked RMI item.

#### 6.4.2 DISPOSAL

Unwanted RAM will be disposed of as LLRW. Preparation of material for disposal and actual disposal shall be conducted under the approved procedures of a licensed waste broker through the Navy Low-Level Radioactive Waste Disposal Program. The status of RAM waste that has been disposed of and removed from the site shall be updated on inventory data sheets and in the RWI to indicate that the item is no longer in storage on site.

### 7.0 RECORDS

Weekly waste inventory reports will be submitted to RASO and retained as records. Additionally, an electronic RWI containing a master list of all RAM waste on site shall be maintained as part of the project files.

### 8.0 REFERENCES

<i>Number</i>	<i>Title</i>
AEC Regulatory Guide 1.86	<i>Termination of Operating Licenses for Nuclear Reactors</i>
10 CFR 20	<i>Standards for Protection Against Radiation</i>
SOP 010	<i>Radiologically Restricted Areas – Posting and Access Control</i>
SOP 012	<i>Release of Materials and Equipment from Radiologically Controlled Areas</i>
SOP 016	<i>Decontamination of Equipment, Material and Tools</i>

### 9.0 ATTACHMENTS

Attachment 1, Stockpile/Container Inventory Log Sheet

Attachment 2, Radioactive Waste Inventory Log Sheet



**ATTACHMENT 2**

## RADIOACTIVE WASTE INVENTORY LOG SHEET

[illegible]

**Standard Operating Procedure**

**RELEASE OF MATERIALS AND EQUIPMENT  
FROM RADIOLOGICALLY CONTROLLED AREAS**

**SOP 012**

**Revision 0**

Prepared By:

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3/16/2012  
Date

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Project Radiation Safety Officer

3/16/2012  
Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

The purpose of this procedure is to specify the radiological survey requirements for releasing materials and equipment from radiologically controlled areas (RCAs).

## 2.0 SCOPE

This procedure will be used by Tetra Tech (Tt) personnel and its subcontractors to release materials from RCAs.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP will assist in the interpretation of results obtained during surveys.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for ensuring that all personnel assigned the task of performing surveys in support of unconditionally releasing materials from controlled areas are familiar with this procedure, trained in the use of this procedure, and have access to a copy of this procedure. The SPM is responsible for the training of personnel performing work detailed by this procedure. The SPM shall ensure that personnel are adhering to the requirements of this procedure. The SPM is responsible for ensuring The Site Supervisor (SS) is implementing this procedure for work performed under their cognizance. The SPM ensures that the Radiological Control Technicians (RCTs) performing activities governed by this procedure are implementing this procedure. The SPM will notify the PHP of any unsafe or unusual conditions observed during performance of this procedure.

**Site Supervisor** – The SS is responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for the control of radioactive material, coverage of radiation workers, and to ensure that personnel under their cognizance observe proper precautions. The SS is responsible for notifying the SPM of any unsafe or unusual conditions observed during performance and implementation of this procedure.

**Radiological Control Technician** – The RCT is responsible for the performance of the requirements of this procedure and documentation of work performed. The RCT shall ensure compliance with this and any other referenced procedure. The RCT is responsible for notifying the SS of unsafe or unusual conditions.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Contamination** – Deposition of radioactive material in any place it is not desired. Contamination may be due to the presence of alpha particle, beta particle or gamma ray emitting radionuclides.

**Fixed Surface Contamination** – Radioactive contamination that is not readily removed from a surface by applying light to moderate pressure when wiping with a paper or cloth disk swipe or masslinn.

**Radiologically Controlled Area (RCA)** – An area containing radioactive materials (in excess of the levels provided in Table 1 of Standard Operating Procedure SOP 010, *Radiologically Controlled Areas – Posting and Access Control*) to which access is controlled to protect individuals from exposure to contamination and ionizing radiation.

**Release for Unrestricted Use** – The authorization to remove or reuse equipment and/or material from a RCA. Such authorization will be based on review of survey data confirming that the material and/or equipment being released does not exhibit radiation levels exceeding those in Table 5-1.

**Removable Surface Contamination** – Radioactive contamination that is readily removed from a surface by applying light to moderate pressure when wiping with a paper or cloth disk swipe or masslinn.

## 6.0 PROCEDURE DETAILS

### 6.1 GENERAL

Materials and equipment will be released from RCAs based on surveys for fixed and removable contamination. Surveys for fixed and removable surface contamination shall

be conducted and documented in accordance with SOP 006, *Radiation and Contamination Surveys*.

## **6.2 LIMITATIONS**

This procedure shall not be used for personnel surveys. Personnel will be surveyed in accordance with SOP 022, *Personnel Protective Equipment, Monitoring, And Decontamination*.

## **6.3 RELEASE PROCEDURE**

### **6.3.1 MATERIAL HISTORY**

Upon receipt of an item presented for release from RCAs, the history of the item should be determined. This determination should include if possible:

- The current and past use of the item.
- The location(s) in which the item was used or stored.
- If the item was in an area where radioactive material was used or stored.

This history will be used, if applicable, to evaluate the potential for contamination to be present on inaccessible surfaces of the item.

### **6.3.2 CONTAMINATION SURVEYS**

All accessible surfaces will be surveyed for removable and fixed surface contamination in accordance with SOP 006, *Radiation and Contamination Surveys*.

Swipes will be taken on all accessible surfaces of the material and equipment. Swipes collected for removable surface contamination shall be analyzed with a Ludlum Model 2929 scaler with a Model 43-10-1 ZnS(Ag) scintillation probe (or equivalent)

Scan surveys will be conducted on all accessible surfaces of the material or equipment. When ever practical 100 percent of the accessible area will be scanned for alpha, beta, and gamma.

Following scan surveys, static survey measurements will be collected. The number of static surveys will be determined by:

- The size and history of the item
- Preliminary results of the swipe and scan surveys
- If an increase in the audible and/or digital/analog count rate was detected

- If during the survey, the RCT determines that there may be fixed activity present

### 6.3.3 INACCESSIBLE SURFACES

If items have inaccessible surfaces, that may have been exposed to contamination, or if it is unknown if they have been exposed to contamination, the items should be disassembled as completely as possible to facilitate release surveys. Items with inaccessible surfaces will not be released from an RCA, unless evaluated and documented by the PHP or designee.

### 6.3.4 RELEASE OF MATERIAL AND EQUIPMENT

The following steps shall be taken for release of material and equipment:

1. If the results of the swipe, scan and static surveys do not exceed the limits of Table 5-1 then the material may be released for unrestricted use.
2. If the swipe, scan or static survey results indicate contamination, which exceeds the limits of Table 5-1, the material shall be secured and managed in accordance with SOP 011, *Control of Radioactive Material*. Material that cannot be released for unrestricted use will be evaluated for decontamination in accordance with SOP 016, *Decontamination of Equipment and Tools*, or packaged for disposal.
3. Results of the swipe, scan and static surveys shall be documented in accordance with SOP 006, *Radiation and Contamination Surveys*.
4. If the equipment and/or materials are being returned to a vendor or removed from the site, a completed Attachment 1 – Unconditional Release of Equipment or Materials Form – will accompany the equipment and/or material.

**TABLE 5-1**  
**RELEASE LIMITS FOR MATERIALS AND EQUIPMENT**

<b>Radiation Type</b>	<b>Release Limits<sup>1</sup> (Fixed) (dpm per 100 cm<sup>2</sup>)</b>	<b>Release Limits<sup>1</sup> (Removable) (dpm per 100 cm<sup>2</sup>)</b>
Alpha ( $\alpha$ )	100	20
Beta ( $\beta^-$ )	1000	200
Gamma ( $\gamma$ )	5,000	1,000

**Notes:**

<sup>1</sup> These limits are based on AEC Regulatory Guide 1.86 (AEC, 1974)

AEC – Atomic Energy Commission

cm<sup>2</sup> – square centimeters

dpm – disintegrations per minute

## 7.0 REFERENCES

<b><i>Number</i></b>	<b><i>Title</i></b>
AEC Regulatory Guide 1.86	<i>Termination of Operating Licenses for Nuclear Reactors</i>
SOP 006	<i>Radiation and Contamination Surveys Procedure</i>
SOP 10	<i>Radiologically Controlled Areas – Posting and Access Control</i>
SOP 011	<i>Control of Radioactive Materials</i>
SOP 016	<i>Decontamination of Equipment and Tools</i>
SOP 022	<i>Personnel Protective Equipment, Monitoring, and Decontamination</i>

## 8.0 ATTACHMENTS

Attachment 1 – Unconditional Release of Equipment or Materials Form.

**ATTACHMENT 1****UNCONDITIONAL RELEASE OF EQUIPMENT OR MATERIALS FORM**

Survey #:		Date:		
Description of equipment or materials:				
<b>SURVEY EQUIPMENT:</b>				
Model No:	S/N:	Background:	Eff:	Cal Due Date:
Model No:	S/N:	Background:	Eff:	Cal Due Date:
Model No:	S/N:	Background:	Eff:	Cal Due Date:
<b>CONTAMINATION LEVELS:</b>				
	dpm/100 cm <sup>2</sup> $\beta\gamma$	Maximum Removable		
	dpm/100 cm <sup>2</sup> $\alpha$	Maximum Removable		
	dpm/100 cm $\beta\gamma$	Maximum Fixed		
	dpm/100 cm <sup>2</sup> $\alpha$	Maximum Fixed		
This is to certify that the above described equipment or materials have been surveyed and found to be within acceptable surface contamination levels for unconditional release as required by Nuclear Regulatory Guide 1.86.				
Radiological Control Technician:				Date/Time:
Disposition of equipment or materials:				
Reviewed By:				Date:

**Standard Operating Procedure**  
**DECONTAMINATION OF EQUIPMENT AND TOOLS**

**SOP 016**

**Revision 0**

Prepared By:

Lawson Bailey  
Project Health Physicist

3/16/2012  
Date

Approved By:

Eric J. Alkensis  
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3/16/2012  
Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

This procedure provides instruction and methods for the decontamination of equipment and tools that are contaminated with radioactive material.

## 2.0 SCOPE

This procedure provides the methods Tetra Tech (Tt) personnel and its subcontractors will use for decontamination of equipment and tools that are contaminated with radioactive material.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is responsible for compliance with this procedure and with updating this procedure as required.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for the implementation of this procedure. This requires conducting periodic reviews of the adherence of personnel to the requirements of this procedure, supervising the personnel performing decontamination activities, and ensuring that the technicians have appropriate knowledge, training, and experience to perform the requirements of this procedure. In addition, the SPM will assign staff to direct and monitor decontamination activities, conduct decontamination operation pre-job briefings, and provide release evaluations of decontaminated materials.

**Site Supervisor** – The Site Supervisor (SS) is responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for ensuring that the Radiological Control Technicians (RCTs) implement and use this procedure. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiation Control Technicians** – RCTs are responsible for performing the surveys of decontaminated items and ensuring that radioactive material is not released to the public or environment.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Decontamination** – The processes whereby contamination can be safely and effectively removed from equipment and tools.

**HERCULITE®** – A plastic or polyethylene floor covering and containment material used for decontamination operations. HERCULITE is a brand name.

**Material Safety Data Sheet (MSDS)** – Manufacturer directions, safety information and limitations for use of decontamination-related solvents or cleaning solution.

## 6.0 PROCEDURE DETAILS

### 6.1 GENERAL

#### 6.1.1 PRECAUTIONS

The following precautions shall be observed during decontamination activities:

- Decontamination of contaminated tools or equipment shall be performed under the supervision of the SS or RCT providing the job coverage.
- Areas used for decontamination shall be posted and controlled in accordance with the provisions of procedure SOP 010, *Radiologically Controlled Areas - Posting and Access Control*.
- Controls to contain the spread of loose contamination during the decontamination activity shall be planned and established prior to the decontamination of equipment, material and tools.
- Use of chemicals or solvents for decontamination purposes that have the potential to produce mixed waste shall be avoided whenever possible. Use of these chemicals or solvents requires the prior approval of the PHP with approval from Radiological Affairs Support Office (RASO).
- Survey instruments that will be used to survey suspected contaminated equipment or tools should be protected (wrapped in plastic, etc.) against possible contamination before use.

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Decontamination of Equipment and Tools

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- Abrasive measures should only be applied to surfaces that are not critical for operation of devices being returned to working condition.
- Electric power tools should not be used on a wet working surface. Liquids will be kept away from electric power tools.

**6.1.2 LIMITATIONS**

The following limitations apply to decontamination activities:

- Protective clothing worn by the personnel involved in decontamination activities shall be determined according to the RWP.
- Decontamination cleaning solvents/solutions shall only be used in accordance with the directions and limitations listed on the manufacturer-supplied MSDS and in accordance with the requirements listed in Section 6.1.1.
- Respiratory protection devices required by the RWP for decontamination operations shall be selected and used in accordance with the provisions of SOP 017, *Radiological Respiratory Protection Policy*.
- A pre-job briefing shall be held to review the conditions of the RWP. All personnel performing work in the decontamination area shall read, understand, and sign the RWP prior to work.
- Contamination controls shall be observed throughout a decontamination operation.
- Radiation and contamination surveys shall be performed in accordance with the provisions of procedure SOP 006, *Radiation and Contamination Surveys*.
- Release of equipment and tools from the decontamination area shall be performed in accordance with the provisions of SOP 012, *Release of Materials from Radiologically Controlled Areas*.

## 6.2 PRE-DECONTAMINATION PREPARATION

The following steps shall be used for pre-decontamination preparation:

1. The SPM, or designee shall review available data regarding the item(s) requiring decontamination and, in consultation with the PHP, develop a decontamination approach from the applicable alternatives described herein. The PHP will have final approval authority of the decontamination approach.
2. A radiological survey shall be performed to identify the level of radioactive contamination that is present by an RCT on objects that are to be removed from a controlled area.
3. If radiological survey results indicate that an RWP is required specifically for item decontamination, the SPM shall prepare the RWP in accordance with the provisions of procedure SOP 002, *Issue and Use of Radiation Work Permits*.
4. The PHP shall approve or disapprove the decontamination operation based on conditions of the RWP and the cost-effectiveness of the operation versus disposal costs.

## 6.3 ESTABLISHMENT OF THE DECONTAMINATION AREA

The SPM shall determine a location for set-up of the decontamination area. As applicable to the specific decontamination activity being performed, the decontamination area may consist of and contain one or more of the following (as needed):

- Covered floor surfaces. A double-layer of HERCULITE (or equivalent) may be laid on the floor at the direction of the RCT.
- Covered (HERCULITE or equivalent) wall surfaces.
- Engineering controls [high-efficiency particulate air (HEPA) ventilation, vacuum cleaners, containment tent walls, glove bags, etc.]. Engineering controls shall be determined on the basis of the as low as reasonably achievable (ALARA) considerations section of the RWP.
- Safe, sturdy work stations with contamination-resistant surfaces, tables that will support decontamination attempts on heavy pieces of equipment.
- Adequate lighting, electrical and compressed air supply for the operation of electrical and/or pneumatic-driven equipment.
- Overhead lifting equipment.

**Decontamination of Equipment and Tools**

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- Adequate supply of approved cleaning solutions and solvents; adequate supply of decontamination equipment such as:
  - Light-duty decontamination equipment such as paper wipes, paper towels, masslin towels, etc.
  - Medium- to heavy-duty decontamination equipment such as scrub pads, wire brushes, steel wool, files, sandpaper, etc.
  - Fully stocked hand tool kit for disassembly of contaminated equipment
  - Power tools, such as drills, saws, needle-guns, electric screwdrivers, etc.
  - Radioactive material storage bags and stickers
  - Buckets, barrels or drums for the storage of contaminated liquids, sludges or slurries
  - Blotter paper or sorbent
  - Approved absorbent material such as oil dry
  - Storage drums/bags for the storage of contaminated protective clothing
  - Proper surveillance instruments (air monitor/sampler, contamination monitor, friskers, exposure rate meter, etc.)
  - Adequate supply of personal protective clothing, gloves, respiratory equipment
  - A designated area within the decontamination area for the segregation of radioactive waste
  - Fire extinguisher(s)

After radiological posting of the decontamination area, all requirements of the RWP shall be observed.

**6.4 ITEM PREPARATION FOR DECONTAMINATION**

Contaminated or controlled items should always be escorted under the direction of a RCT to the decontamination area.

If an item is wrapped, position it so that the written information on the wrapping is visible and then perform the following:

- The RCT shall direct the removal of the item from the wrapping in such a manner (rolling plastic wrapping inside out, etc.) to control the spread of contamination.

**Decontamination of Equipment and Tools**

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- An item that is highly contaminated with removable contamination may need to be misted with an approved liquid to minimize the possibility of creating airborne contamination.
- Once the item has been removed from the wrapping and has been properly positioned, discard the wrapping as radioactive waste.

The following conditions shall be considered for the decontamination of equipment and tools:

- Any equipment with inaccessible areas shall be dismantled so that all surfaces are accessible for decontamination and survey.
- Decontamination shall be performed in a safe, effective manner.
- The PHP shall be notified immediately if the job conditions change (e.g., suspected asbestos is found, the presence of mercury in a switch or a light bulb, a fluid leak, or any other special circumstances).
- A fire watch shall be assigned to watch if any spark-producing decontamination techniques (grinding, etc.) are used. There shall be a dedicated fire extinguisher located within the decontamination area.
- The decontamination area shall remain organized and free of debris. The Radiological Control/ Decontamination Technicians shall "clean as they go."
- Air monitoring for airborne radioactivity shall be conducted as needed or directed by the RWP.
- A HEPA vacuum cleaner may be used during the decontamination operation.

**6.5 DECONTAMINATION OF REMOVABLE CONTAMINATION**

When an item is properly positioned for decontamination and the pre-survey activities have been completed, the RCT will perform one or more of the following activities in accordance with the decontamination action approach approved by the PHP:

- Moisten the surface of the item with an approved liquid.
- Fold a paper or cloth wipe into sections, using one surface of the wipe; gently wipe contamination off in one direction away from the user's body to reduce the possibility of personnel contamination.
- Re-fold the paper or cloth wipe so that a clean surface is available to prevent cross-contamination and continue until item is ready for survey.
- For some equipment or tools, duct tape will effectively remove removable contamination. Wrap the duct tape loosely around the gloved hand, adhesive side out. Roll the tape over the contaminated area.

## 6.6 DECONTAMINATION OF FIXED CONTAMINATION

There are many techniques that can be used to remove fixed contamination. The general idea is to remove the material that is fixing the activity to the surface, or remove a very thin layer of the surface material. It is very important to note that fixed contamination decontamination methods can and do result in the creation of removable surface contamination. This creates a condition that may generate airborne radioactive materials. The activities should be controlled in such a manner that airborne radioactivity is minimized, and air sampling shall be performed during these operations to properly evaluate any resultant airborne radioactivity. Air monitoring activities will be performed in accordance with SOP 008, *Air Sampling and Sample Analysis*.

For the purposes of this procedure, the potential removal techniques have been divided into the following two categories:

- Abrasive hand decontamination
- Power tool decontamination

In addition, the following methods could be used, but are not defined in this procedure and would require the development of a Task-specific Plan or Work Instruction:

- Machine decontamination (use of abrasive bead blasters, grit blasters, high-pressure water wash systems, etc.)
- Cleaning solutions/solvents (use of ultrasonic cleaners, acid baths, electropolishing, etc.).

The actual method or combination of methods applied will be in accordance with the decontamination approach approved by the PHP.

### 6.6.1 ABRASIVE HAND DECONTAMINATION

Abrasive hand decontamination shall be performed in the following manner:

1. Remove as much removable contamination as possible as indicated in Section 6.5 of this procedure.
2. Moisten the surface of the item(s) to help contain contamination.
3. Use an abrasive cleaning tool (e.g., sandpaper, steel wool, steel brush, hand grinder, etc.) to loosen fixed contamination. Clean in one direction only, away from the body to prevent personnel contamination.
4. Continue to moisten the surface of the item(s) to contain contamination.
5. Remove as much of the loosened contamination as possible as per Section 6.5 of this procedure.

## **6.6.2 POWER TOOL DECONTAMINATION**

Power tool decontamination shall be performed under the direction of the RCT, with concurrence from the PHP.

### **6.6.2.1 Electric Power Tools**

Electric power tools that may be used in decontamination operations are:

- Drills - used to drill out contaminated areas, to disassemble contaminated components, and when used with grinding wheels or disks, may be used as an abrasive tool
- Saws - used to separate contaminated pieces from clean pieces
- Grinders - used to grind fixed contamination from surfaces
- Electric screwdrivers - used in the disassembly of component parts

### **6.6.2.2 Air-powered Tools**

Air-powered tools that may be used in decontamination operations are:

- Needle gun - a pneumatic tool that can remove contamination from concrete and/or steel surfaces
- Socket tools or impact hammer - used in disassembly of component parts
- Jackhammer/rotary hammer - a pneumatic tool which can remove contamination from concrete and/or steel surfaces

### **6.6.2.3 Decontamination of Power Tools**

Power tool decontamination shall be performed in the following manner:

1. Remove as much removable contamination as possible as per Section 6.5 of this procedure.
2. Moisten the surface of the item lightly to help contain contamination. Use a spray bottle for moistening.
3. Whenever feasible the use of containment devices (e.g., glove box, etc.) should be used to contain the spread of contamination when using power tools for decontamination operations.
4. Use the power tool to remove fixed contamination. Clean in one direction only and away from the body to prevent personnel contamination.

## 6.7 POST-DECONTAMINATION

Following decontamination procedures, the RCT shall perform a release survey. The survey will include the work area and any tools, equipment and materials used during decontamination activities and shall be conducted in accordance with SOP 012, *Release of Materials from Radiologically Controlled Areas*. Post-decontamination release shall be performed as follows:

1. If the item satisfies the criteria for release, remove the item to a holding area and document results.
2. If the item remains contaminated, inform the SPM and repeat the decontamination.
3. If the item remains contaminated, attempt a third decontamination only by direction of the PHP.

If an item cannot be effectively or economically decontaminated, the SPM may direct the crew to volume-reduce (reduce to component parts) the equipment, material, or tools as much as possible. If the item is expendable, the individual parts may be surveyed and released.

Any tools, equipment or materials that cannot be decontaminated will be packaged in an appropriate waste container for subsequent disposal as radioactive waste. The waste containers will be staged in Building 406 and maintained under New World Technology, Inc.'s license, until disposed of via the Navy's Low-level Radioactive Waste program.

After decontamination operations have been completed, a RCT shall perform a release survey of the decontamination area and de-post the area in accordance with SOP 006, *Radiation and Contamination Surveys*, SOP 010, *Radiologically Controlled Areas – Posting and Access Control*, and SOP 012, *Release of Materials from Radiologically Controlled Areas*.

## 7.0 RECORDS

The records generated by the use of this procedure are documented in accordance with the provisions of SOP 012, *Release for Materials from Radiologically Controlled Areas*, and SOP 017, *Radiological Respiratory Protection Policy*.

## 8.0 REFERENCES

<b><i>Number</i></b>	<b><i>Title</i></b>
SOP 002	<i>Issue and Use of Radiation Work Permits</i>
SOP 006	<i>Radiation and Contamination Surveys</i>
SOP 008	<i>Air Sampling and Sample Analysis</i>
SOP 010	<i>Radiologically Controlled Areas - Posting and Access Control</i>
SOP 012	<i>Release of Materials from Radiologically Controlled Areas</i>
SOP 017	<i>Radiological Respiratory Protection Policy</i>

## 9.0 ATTACHMENTS

None.

**Standard Operating Procedure**  
**RADIOLOGICAL RESPIRATORY PROTECTION POLICY**

**SOP 017**

**Revision 0**

Prepared By:

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3/16/2012  
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3/16/2012  
Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

The purpose of this procedure is to ensure protection of personnel from internal exposure to radioactive materials. This procedure describes the requirements and policies associated with respiratory protection during activities while working in an airborne radioactivity area.

## 2.0 SCOPE

This procedure will be used by Tetra Tech (Tt) personnel and its subcontractors to implement radiological respiratory protection.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) maintains and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Safety Officer** – The Site Safety Officer (SSO) shall be responsible for the training of personnel in the selection and use of respirators. The SSO shall ensure that all workers are qualified by training and experience to perform the requirements of this procedure. The SSO, or designee, shall be responsible for performing qualified fit tests for all radiation workers. The SSO shall conduct periodic reviews, via personal observation, of use of respiratory protection to ensure adherence to the requirements of this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for the implementation and compliance with this procedure as it pertains to radiological activities. The SPM shall be responsible for ensuring that personnel performing the tasks required by this procedure are properly assigned. The SPM is responsible for

ensuring that personnel using respiratory protection are familiar with the requirements of this procedure and have access to a copy of the Radiation Work Permits (RWPs).

**Site Supervisor** – The Site Supervisor (SS) shall be responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for ensuring that the Radiological Control Technicians (RCTs) implement and use this procedure. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technician** – The RCT shall be responsible for ensuring that radiation workers are following the requirements of this procedure and that all documentation is prepared properly.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Airborne Radioactivity Area** – A room, enclosure or area in which radioactive material is dispersed in air in the form of dusts, fumes, particulates, mists, vapors, or gases, and the concentration of the dispersed radioactive materials is in excess of:

- The derived air concentrations (DACs) specified in Table 1, Column 3 of Appendix B, Title 10 Part 20 of CFR.
- Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI).

**Derived Air Concentration (DAC)** - The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one Annual Limit on Intake (ALI). DAC values are given in Table 1, Column 3, of Appendix B of 10 Code of Federal Regulations (CFR) 20 (1-92), *Standards for Protection Against Radiation*. One DAC-Hr is approximately 2.5 mrem total effective dose equivalent.

## 6.0 PROCEDURE DETAILS

### 6.1 GENERAL

Engineering and process controls shall be used to the extent practicable to limit the concentrations of airborne radioactive materials to levels less than 10 percent of the DAC values listed in Table 1, Column 1, of Appendix B, 10 CFR 20.

When it is impractical to use engineering and process controls, or while they are being implemented, other precautionary steps such as limiting stay times, increased surveillance and/or the use of respiratory protective equipment may be used to limit the intake of airborne radioactive materials.

No emergency situations involving potential respiratory hazards are expected under use of this program.

Although respiratory protection for potential radiological exposure may not be required by this procedure, respiratory protection as required by the Site Safety and Health Plan for other chemical contaminants may be required.

## **6.2 RADIOLOGICAL CRITERIA FOR RESPIRATOR USE**

Use of a respirator is required when airborne radioactivity concentrations cannot be maintained at less than 10 percent of DAC values (Table 1, Column 1, of Appendix B, 10 CFR 20).

Individuals approved to select respiratory protection equipment for use by others shall consider the nature and extent of the hazard, the work requirements and conditions, and the characteristics and limitations of the respirators available.

Respirators should be selected on the basis of airborne contamination levels that develop during work activities.

Radiological respiratory protective equipment shall be selected to provide a protection factor greater than the multiple by which peak concentrations of radioactive materials are expected to exceed the values in Table 1 Column 1, of Appendix B, 10 CFR 20. The equipment selected shall be used so that the average concentration of radioactive material inhaled during any period of uninterrupted use in an airborne radioactivity area, on any day, by an individual using the equipment, shall not exceed the values specified in Table 1, Column 1, of Appendix B, 10 CFR 20.

Personnel exposure to airborne radioactivity should not exceed 10 DAC-Hrs in any 7 consecutive days.

## **6.3 AIR SAMPLING PROGRAM**

The air sampling program is established to provide adequate identification of all respiratory hazards present, including radiological, oxygen-deficient and toxic materials.

Air sample data will be used to select the proper respirator and provide estimates of worker exposure.

Air samples will be representative of the air being breathed by the worker(s).

Air sampling program details are presented in SOP 008.

#### **6.4 BIOASSAY PROGRAM**

Measurements of radioactive materials in the body and/or excreted from the body will be performed as necessary for timely detection and assessment of individual intakes of radioactive materials. The techniques used, (e.g., whole-body counts, urine samples, etc.) will be appropriate with respect to the material exposed. Baseline bioassay data shall be obtained.

Periodic bioassay samples will be taken, as needed, to determine the adequacy of the respiratory protection program and will be used to determine actual exposures, if any.

#### **6.5 EFFECTIVENESS OF THE RESPIRATORY PROTECTION PROGRAM**

Periodic surveillance of individuals working in respirators will be performed to evaluate actual exposures and monitor workers stress and equipment performance. Any problems shall be reported to the PHP or designee.

#### **6.6 RESPIRATOR SURVEY AND DECONTAMINATION**

Survey the respirator and cartridge for radioactive contamination.

Remove the P-100 (High Efficiency Particulate Air) cartridge and properly dispose of as radioactive waste (if required).

Respirators with  $> 10,000$  disintegrations per minute (dpm)/100 square centimeters ( $\text{cm}^2$ )  $\beta\gamma$  and/or 200 dpm/100  $\text{cm}^2$   $\alpha$  removable contamination shall be decontaminated using the following steps:

- Fill a container with warm water.
  - Add cleaner/sanitizer, or 2 fluid ounces of chlorine bleach per gallon of water used.
- Gently scrub the respirator with a soft bristle brush, sponge, or cloth.
- Thoroughly rinse the respirator in warm water and allow it to air dry.
- Re-survey the respirator after it is completely dry for removable and fixed contamination.

The RCT shall thoroughly swipe the respirator with a disc swipe. Swipes should be counted on a Ludlum Model-2929 or equivalent to determine the activity level of the swipe. If removable contamination is below the release limits, a direct survey of the respirator will be performed. If removable contamination is above the release limits; the respirator shall be re-washed and re-surveyed. The removable contamination release limits are:

- Alpha < 20 dpm/100 cm<sup>2</sup>
- Beta-gamma < 200 dpm/100 cm<sup>2</sup>

After the respirator is determined to meet removable contamination criteria, the respirator shall be direct surveyed with a Ludlum Model-3 instrument or equivalent equipped with a Model 44-9 (Beta-Gamma) probe or equivalent, and a Ludlum Model-3 instrument or equivalent equipped with a Model 43-5 (Alpha) probe or equivalent. The fixed activity of the respirator shall be determined in accordance with the operating procedure of the instrument used and if acceptable, document the survey results. If unacceptable, the RCT shall identify the respirator and remove the respirator from service. The fixed activity limits shall be:

- 1,000 dpm/100 cm<sup>2</sup> net beta-gamma and 20 dpm/100 cm<sup>2</sup> net alpha on the interior of the respirator per direct scan.
- 5,000 dpm/100 cm<sup>2</sup> net beta-gamma and 100 dpm/100 cm<sup>2</sup> net alpha on the exterior of the respirator per direct scan.

The survey results for each respirator will be documented.

## 7.0 RECORDS

Records of the following shall be maintained for each individual who wears respiratory protection devices (other than dust masks) at any worksite:

- Physical qualifications
- Fit testing
- Respirator issue
- Respirator maintenance
- Bioassay data - before and after exposure
- Air sample results
- Respirator Evaluation/Repair Report

## 8.0 REFERENCES

Number	Title
10 CFR 20	<i>Standards for Protection Against Radiation</i>
SOP 008	<i>Air Sampling and Sample Analysis</i>

## 9.0 ATTACHMENTS

None.

**Standard Operating Procedure**  
**RADIOLOGICAL PROTECTIVE CLOTHING SELECTION,**  
**MONITORING AND DECONTAMINATION**

**SOP 022**

**Revision 0**

Prepared By:

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3/16/2012

Date

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3/16/2012

Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

This procedure provides the methods for donning, wearing, and removing protective clothing while working within, accessing or leaving known or suspected areas with radioactive contamination.

## 2.0 SCOPE

This procedure will be used by Tetra Tech (Tt) personnel and its subcontractors while performing activities in known or suspected areas with radioactive contamination.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) maintains and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible the overall implementation and compliance with this procedure during all project operations. The SPM is responsible for ensuring that personnel assigned tasks involving access to radiological controlled areas (RCAs) are adequately trained in the use of protective clothing, are familiar with the requirements of this SOP, and have access to a copy of the associated Radiation Work Permits (RWPs).

**Site Supervisor** – The Site Supervisor (SS) is responsible for the control of radioactive material, coverage of radiation workers, and assuring that personnel under their cognizance observe proper precautions. Documentation required by this procedure will be reviewed by the SS, or designee.

**Radiological Control Technician** – The Radiological Control Technician (RCT) shall be responsible for the performance of the requirements of this procedure and documentation of work performed.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Contaminated Area** – Any area where removable surface contamination levels exceed the following limits:

### EQUIPMENT AND MATERIAL SURFACE CONTAMINATION LIMITS

Radionuclide	Removable <sup>1</sup> (dpm/100 cm <sup>2</sup> )	Fixed <sup>1</sup> (dpm/100 cm <sup>2</sup> )
Alpha	20 $\alpha$	100 $\alpha$
Beta (Strontium-90)	200 $\beta^-$	1,000 $\beta^-$
Beta / Gamma	1,000 $\beta^-, \gamma$	5,000 $\beta^-, \gamma$

**Notes:**

<sup>1</sup> Limits for equipment and materials based on Regulatory Guide 1.86 (AEC, 1974)

AEC – Atomic Energy Commission

cm<sup>2</sup> – square centimeters

dpm – disintegrations per minute

**Hot Particle** – A discrete, minute, fragment of radioactive material.

**Radiologically Controlled Area (RCA)** – An area containing radioactive materials to which access is controlled to protect individuals from exposure to contamination and ionizing radiation.

## 6.0 PROCEDURE DETAILS

### 6.1 SELECTION OF PROTECTIVE CLOTHING

The following factors should be considered when selecting protective clothing (PC):

- The levels and types of radiological material present or expected in the work area.
- The presence of chemical hazards.
- The base in which the contamination is carried (dry, wet, oily).
- The work to be performed or work in progress.

- The location of the contamination (e.g. floor, walls, overhead, air handling systems, sewer systems).
- The physical configuration of the work area.
- Environmental conditions such as heat and humidity.
- Exposure situation (vapor, pressured splash, liquid splash, intermittent liquid contact, and continuous liquid contact).
- Toxicity of the radioactive materials and/or chemical(s) (ability to permeate the skin and systemic toxicity).
- Physical properties of the contaminant (vapor pressure, molecular weight, and polarity).
- Functional requirements of the task (dexterity, thermal protection, fire protection, and mechanical durability requirements).

Table 6-1 provides guidance for the selection of protective clothing when radiological hazards are present or suspected.

**TABLE 6-1**  
**GUIDE FOR THE SELECTION OF RADIOLOGICAL PROTECTIVE CLOTHING**

<b>Removable Contamination Levels</b>	<b>Clothing for Access Only <u>No Work</u> *</b>	<b>Clothing for Work or Access During Work *</b>
General contamination levels < 1000 dpm/100 cm <sup>2</sup>	Level D PPE	Level D PPE
General contamination levels > 1000 dpm/100 cm <sup>2</sup> , but ≤ 10,000 dpm/100 cm <sup>2</sup>	Glove liners Gloves Booties, cloth or PVC Tyvek Rubber shoe covers**	Glove liners Gloves Booties, cloth or PVC Tyvek Rubber shoe covers**
General contamination levels > 10,000 dpm/ 100 cm <sup>2</sup> , but ≤ 100,000 dpm/100 cm <sup>2</sup>	Glove liners Gloves Booties, cloth or PVC Tyvek Cap (or hood) Rubber shoe covers**	Glove liners Gloves Booties, cloth or PVC Tyvek Cap (optional) Hood Rubber shoe covers**
General contamination levels > 100,000 dpm/100 cm <sup>2</sup>	Glove liners Gloves (2 pair) Booties, cloth or PVC Tyvek Cap (optional) Hood Rubber shoe covers**	Glove liners Gloves (2 pair) Booties (2 pair), cloth or PVC Tyvek (2 pair) Cap Hood Rubber shoe covers**

**Notes:**

\* Plastics or partial plastics may be required anytime water or liquid chemicals are present, such as when handling wet components.

\*\* Composition of Rubber shoe covers will be selected based on work area conditions and presence of any chemical hazards.

cm<sup>2</sup> – square centimeters

dpm – disintegration per minute

PPE – personal protective clothing

PVC – polyvinyl chloride

The guidelines specified in Table 6-1 for protective clothing selection may be modified under unusual circumstances. The following are examples:

- Wet areas - Where splashing water or spray is present, use rain suits in addition to the protective clothing listed in Table 6-1. A second set of coveralls may not be necessary when a rain suit is worn.
- Standing water - In addition to the clothing requirements for wet areas, use hip boots or waders for deep standing water areas.
- Face shields – Consider for use when there is significant beta radiation or a likelihood of water splashing and respirators are not required.
- High temperature areas - Consult with the SPM and Site Safety Officer (SSO).

Actual requirements will be specified in the RWP.

## **6.2 PROCEDURE PROCESS**

### **6.2.1 DONNING PROTECTIVE CLOTHING**

1. Select the protective clothing specified on the RWP.
2. Inspect the clothing for holes, tears, or other indications of damage. If damaged, remove protective clothing from service.
3. Put on any additional required special dosimetry (for example, finger rings) prior to donning protective clothing.
4. Place dosimetry, if worn, in the upper body area on interior portion of the breast tab with the window of the dosimeter facing out. When Tyvek is worn that does not have a breast tab or pocket, dosimetry should be attached per the direction of the SPM, or designee.
  - The dosimeter shall not be worn inside clothing or placed in pockets if exposure of bare skin to beta radiation is expected.
5. If a respirator is specified on the RWP, then:
  - Ensure that any required surgeons cap or hood is situated such that it will not interfere with the respirator face to facepiece seal area.
  - Don the respirator.
  - Don the hood if required, allowing it to overlap the rubber around the lens of the face piece and fall over the shoulder.
  - If required, tape the hood to the respirator and to the coveralls.
  - Ensure that any required hood is slack enough around the shoulders to allow for full head movement.
6. Don rubber gloves.

- More than one pair of rubber gloves may be required for certain jobs.
- Tape the innermost pair of rubber gloves to the coverall sleeves.
- Leather work gloves may be substituted for outer rubber gloves on some jobs as specified by the corresponding RWP.

7. If specified on the RWP, then don additional PPE as required.

### 6.2.2 REMOVAL OF PROTECTIVE CLOTHING

1. Remove any tape and place in the designated collection receptacle.
2. Remove outer gloves, if worn.
3. If worn remove the hood and place it in the designated collection receptacle.
4. If worn, then remove respirator.
5. Remove dosimetry if worn and place on the final step-off-pad.
6. Remove coveralls by peeling off inside out and rolling downward over the shoes or inner booties.
7. Carefully place coveralls in the designated collection receptacle.

<p><b>CAUTION:</b> Pushing clothing or trash into an already full collection container to compress the contents is forbidden as the act can result in the potential for airborne radioactivity.</p>
---

8. Perform a personal self frisk, or be frisked by an RCT, in accordance with corresponding RWP requirements and check dosimetry, if worn.

The sequence for protective clothing removal may vary from that described above:

- At the discretion of the RCT providing job coverage.
- As designated on the assigned RWP.
- Dependent upon radiological and hazardous material conditions encountered during the work evolution.

### 6.2.3 MONITORING

#### 6.2.3.1 Exit Surveys

1. Use the portable instrument staged for the area of concern, which should have both a visual and an audible response.

2. Ensure that the instrument is set on slow response, if available, and operating with an audible response.
3. Verify that the instrument is operational on the lowest scale and that the area background count rate is acceptable.
4. Hold the detector with the window at approximately ½ inch from the surface being monitored.
5. Move the detector over the surface being monitored at a rate not to exceed 2 to 3 inches per second.
6. If an increase in the audible response is noted, then cease detector movement and allow the meter 5 to 10 seconds to stabilize.
7. Pause (approximately 5 seconds) at the nose and mouth area to check for indications of inhalation/ingestion of radioactive material.
8. Pay particular attention to hands, feet (shoes), elbows, knees, or other areas with a high potential for contamination.
9. If no contamination can be detected as indicated by an alarm or by an audible or visual response distinguishable from background, then exit the area.
10. If an audible or visual response distinguishable from background is noted, then notify the RCT.
11. Remain in the area until a RCT arrives to provide assistance.
12. If personnel are found to be contaminated, proceed to the procedures outlined in Section 6.2.3.2.

#### 6.2.3.2 Contaminated Personnel

1. Notify the SPM or SS of any individual with known or suspected contamination.
2. If the contamination is on a personal article of clothing, then perform the following:
  - Survey the inside surface(s) which was against the skin.
  - Verify that no contamination was transferred to the skin.
3. If the contamination is on the skin, then determine if the contamination is in the form of a hot particle.
4. If the contamination is a hot particle, then:
  - Quickly evaluate the particle.
    - Particle size
    - Radiation type
    - Visible characteristics
  - Attempt to collect and retain the particle for subsequent evaluation.

- Decontaminate the individual in accordance with Section 6.2.4.
5. If the contamination is not a particle, then:
    - Evaluate the contamination levels.
    - Decontaminate the individual in accordance with Section 6.2.4.
  6. Complete the applicable parts of the Personnel Contamination Report (Attachment 1).

#### 6.2.4 PERSONNEL DECONTAMINATION

**NOTE:** First aid measures take precedence over decontamination efforts. The SS shall request support from qualified medical personnel when an injured person requires decontamination.

1. Perform personnel decontamination in a manner that prevents the spread of contamination to other body parts or the ingestion or inhalation of radioactive material.
2. Take appropriate precautions to minimize the spread of contamination when proceeding from the control point or step-off pad to the decontamination area.
3. Personnel will not be released if detectable skin contamination is present unless authorized by the PHP or designee.
4. When performing skin decontamination:
  - Exercise care to avoid damaging the skin.
  - If skin irritation becomes apparent, then discontinue the decontamination and notify the SPM and PHP.
  - Record results after each decontamination attempt.
  - Indicate the method of decontamination used.
  - Decontamination of ears, eyes and mouth shall be limited to damp swabs, water or saline solution rinses conducted by the individual. Further decontamination shall be performed under the direction of qualified medical personnel.
  - Decontamination of nasal passages shall be limited to repeated nose blowing by the individual. Supplemental nasal irrigations shall be performed under the direction of qualified medical personnel, as required.
  - Use of decontamination processes or materials other than those listed in Table 6-2 will only be performed under the specific direction of qualified medical personnel.

- Immediately report incidents of individual contamination to the SPM and PHP.
- Note the final survey results and time of survey.
- Record the area of the skin contaminated in  $\text{cm}^2$  on Attachment 1.
- For contamination distributed over an area greater than or equal to the area of the probe, the measured activity may be assumed to be distributed over the probe area (area of typical pancake probe is  $15.5 \text{ cm}^2$ ).
- If the area of contamination is less than the area of the probe but greater than  $1 \text{ cm}^2$ , the actual area of the activity must be determined.
- If the contamination area is less than or equal to  $1 \text{ cm}^2$ , assume an area of  $1 \text{ cm}^2$ .
- When skin decontamination has been successfully completed, obtain the information needed to complete the Personnel Contamination Report.
- Complete the applicable parts of the Personnel Contamination Report (Attachment 1).

**TABLE 6-2**  
**PERSONNEL DECONTAMINATION METHODS**

<b>METHOD</b>	<b>EFFECTIVE FOR</b>	<b>INSTRUCTIONS</b>
Masking Tape	Dry contamination, Hot particles	Apply tape to skin by lightly patting. Remove carefully.
Waterless Hand Cleaner	All skin contamination	Apply to affected area and allow it to melt onto the skin. Remove with cotton or soft disposable towel.
Soap and Tepid Water	All skin contamination except tritium	Wash area with soap and lukewarm water. Repeat until further attempts do not reduce the level. A cloth or surgical hand brush may be used with moderate pressure.
Soap and Cool Water	Tritium contamination	Wash area with soap and cool water. Repeat until further attempts do not reduce the level. A cloth may be used with moderate pressure.
Carbonated Water	All skin contamination	Apply to affected area with cotton or soft disposable towel and wipe with dry towel.
Cornmeal Detergent Paste	All skin contamination	Mix cornmeal and powder detergent in equal parts with enough water to form a paste. Rub onto affected area for 5 minutes. Remove with cotton or disposable towel. Rinse skin.
Shampoo	Hair contamination	Wash hair and rinse. Repeat as necessary.
Parafilm	All particulate contamination	Apply to affected area of skin. Remove.
Sweating	All skin contaminations	Cover affected area with impermeable cover (plastic, glove, Parafilm) to cause sweating. Remove after sweating has occurred and wipe area.

### 6.2.5 RADIOLOGICAL FOLLOW-UP

The RCT shall:

1. Ensure that the Personnel Contamination Report (Attachment 1) has been completed.

2. Check the location of the contamination event - Contaminated Area, Hot Particle Area, clean area inside a radiological control area (RCA), or clean area outside RCA.
3. Enter any additional information felt to be pertinent.
4. Complete the "Contamination Event Description and Cause" sections of Attachment 1.
5. If the event was directly related to wearing protective clothing, then complete Section A, "Event Directly Related to Wearing PC".
  - Check the appropriate Contamination Event Description.
  - Check the appropriate Basic Cause.
6. If the contamination occurred while removing protective clothing, then complete Section B, "Event Occurred While Removing PC".
  - Check the appropriate "Contaminating Event Description".
  - Check the appropriate "Basic Cause".
7. If the contamination event was not related to wearing protective clothing, then complete Section C, "Event Not Directly Related to Using PC".
  - Check the appropriate "Contaminating Event Description".
  - Check the appropriate "Basic Cause".
8. Review the report with the individual and have them sign and date the form.
9. Sign and date the form.

The SS shall:

1. Review the Personnel Contamination Report to verify that all required information has been accurately recorded.
2. Complete the "Radiological Task Supervisor" section.
  - Check the appropriate brackets ([ ]) to indicate actions taken.
  - Enter any comments.
3. Sign and date the form.
4. Request support from the qualified medical personnel when:
  - The personnel decontamination methods provided in this procedure are ineffective; or
  - Injured personnel require decontamination.

5. Determine reimbursements and disposition of personal property that cannot be decontaminated.
6. Forward the completed Personnel Contamination Report to the SPM for review.

The SPM and Site Safety Officer shall:

1. Review and sign the Personnel Contamination Report.
2. Conduct an investigation into the cause of the contamination.
3. Conduct training on the cause of the contamination and lessons learned and preventive measures.
4. Sign and transmit the Personnel Contamination Report to the PHP or designee for review.

## 7.0 RECORDS

The administrative form included in this procedure (Personnel Contamination Report) shall not be modified without the written authorization of the SPM and the documented concurrence of the PHP or designee. In no case shall modifications reduce the content required by the original form.

## 8.0 REFERENCES

<i>Number</i>	<i>Title</i>
None	

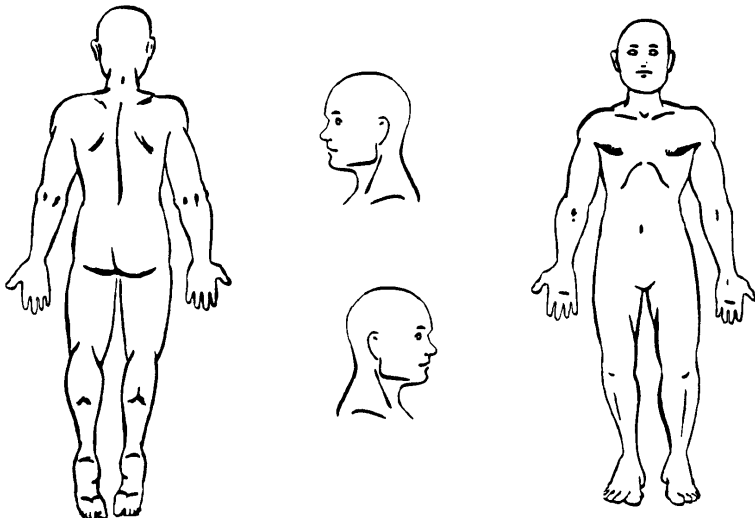
## 9.0 ATTACHMENTS

The following form is attached to this procedure:

Attachment 1, Personnel Contamination Report

## ATTACHMENT 1

### PERSONNEL CONTAMINATION REPORT

Name		Company	Date	Time
EID	Dosimeter#	Dept.	Supervisor	
Instrument		Serial #	Cal. Due Date	
Probe		Serial #	Cal. Due Date	
Location of Personnel Contamination			RWP #	
			Survey #	
				

Contamination Levels (Use # to reference drawing)					
Number	Time	Initial Count Rate	Size of Area (cm <sup>2</sup> )	Time	Final Count Rate
Decontamination Methods	___ Wash      ___ Number of washes			___ Other:	
	___ Shower      ___ Number of showers				
Radiological Control Technician Signature:				Date	
I acknowledge the above information represents the contamination event.					
Individual Signature:				Date	

Name

EID

**CLOTHING CONTAMINATION**

Item:	Max cpm	<input type="checkbox"/> Decon/Return	<input type="checkbox"/> Contaminated/Retained
Item:	Max cpm	<input type="checkbox"/> Decon/Return	<input type="checkbox"/> Contaminated/Retained
Item:	Max cpm	<input type="checkbox"/> Decon/Return	<input type="checkbox"/> Contaminated/Retained

**RADIOLOGICAL FOLLOW-UP**

Location of Event:	<input type="checkbox"/> Contamination Area	<input type="checkbox"/> Clean area inside RCA	<input type="checkbox"/> Clean area outside RCA
Follow-up actions:			
Additional information:			

**CONTAMINATION EVENT DESCRIPTION and CAUSE****A - Event Directly Related To Wearing PC**Contaminating Event DescriptionBasic Cause

- |   |   |
|---|---|
| <input type="checkbox"/> Contaminated by physical compromise of PC (tear, etc.) | <input type="checkbox"/> Improper donning of PC                                 |
| <input type="checkbox"/> Contamination penetration of intact PC                 | <input type="checkbox"/> Improper PC use related to worker knowledge/experience |
| <input type="checkbox"/> Contamination came from PC                             | <input type="checkbox"/> Work area not deconned to extent practicable           |
| <input type="checkbox"/> Contaminated skin by touching contaminated item        | <input type="checkbox"/> Practical limitation of available alternatives         |
| <input type="checkbox"/> Contamination came from contaminated liquid            | <input type="checkbox"/> Improper PC requirement on RWP                         |
| <input type="checkbox"/> Contamination came from airborne radioactivity         | <input type="checkbox"/> Improper control by RCT of worker activity in PC       |
|   | <input type="checkbox"/> Improper laundry/monitoring of PC                      |

**B - Event Occurred While Removing PC**Contaminating Event DescriptionBasic Cause

- |   |   |
|---|---|
| <input type="checkbox"/> Contaminated during removal of hood                  | <input type="checkbox"/> Lack of knowledge in proper methods to remove PC         |
| <input type="checkbox"/> Contaminated during removal of respiratory equipment | <input type="checkbox"/> Lack of knowledge in proper methods to remove respirator |
| <input type="checkbox"/> Contaminated during removal of outer PC              | <input type="checkbox"/> Worker actions while removing PC - accident              |
| <input type="checkbox"/> Contaminated during removal of inner PC              | <input type="checkbox"/> RCT technician actions                                   |
| <input type="checkbox"/> Contaminated during removal of plastics              | <input type="checkbox"/> Improper monitoring of PC                                |
| <input type="checkbox"/> Contamination came from airborne radioactivity       |   |

**C - Event Not Directly Related To Using PC**Contaminating Event DescriptionBasic Cause

- |  |  |
|--|--|
| <input type="checkbox"/> Contaminated while in area designated as clean RCA    | <input type="checkbox"/> Noncompliance with postings/rad controls                    |
| <input type="checkbox"/> Contaminated while in area designated clean non - RCA | <input type="checkbox"/> Improper monitoring/control of rad material by worker       |
| <input type="checkbox"/> Contaminated by liquid                                | <input type="checkbox"/> Improper actions at work area (sitting, lying)              |
| <input type="checkbox"/> Contamination spread to area and not identified       | <input type="checkbox"/> Accidental contact with contamination beyond worker control |
| <input type="checkbox"/> Improper control of airborne radioactive material     | <input type="checkbox"/> Surveys not appropriate for existing conditions             |

**Health Physics Supervisor**

- |   |  |
|---|--|
| <input type="checkbox"/> Interview with job coverage RCT            | <input type="checkbox"/> Released with residual contamination          |
| <input type="checkbox"/> Exclude individual from further RCA access | <input type="checkbox"/> Initiated skin dose calculation               |
| <input type="checkbox"/> Discussed with individual and supervisor   | <input type="checkbox"/> No further action required, routine close out |

Site Supervisor

Print

/

Sign

Date

Site Project Manager

Print

/

Sign

Date

Radiation Safety Officer

Print

/

Sign

Date

# Standard Operating Procedure

## SOURCE CONTROL

SOP 023

Revision 0

Prepared By:

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3/16/2012

Date

Approved By:

Eric J. Alkensis  
Project Radiation Safety Officer

3/16/2012

Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

This procedure details the requirements for the control and accountability of radioactive sources. This procedure implements the requirements of 10 CFR 20.

## 2.0 SCOPE

This procedure applies to all Tetra Tech (Tt) and subcontractor personnel who are involved in the requisition, inventory, storage, control, use of exempt and accountable radioactive sources. This procedure applies to other subcontractor personnel to the extent specified in subcontract documents. It does not apply to devices containing radioactive material as an integral part of their function [i.e., smoke detectors, emergency exit markers, welding rods, and such items as are generally licensed by the Nuclear Regulatory Commission (NRC)(except measuring gauging or controlling devices)] or to radioactive material, analytical samples and radioactive waste.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All incidents/notifications shall be reported to the PRSO.

**Project Health Physicist** – The PHP is responsible for the overall implementation and compliance with this procedure during all project operations. The PHP or designee shall ensure that personnel are adhering to the requirements of this procedure. The PHP or designee shall review and approve documentation generated by this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible ensuring that adequate storage is available for radioactive sources. The SPM is also responsible for designate authorized radioactive source users.

**Site Supervisor** – The Site Supervisor (SS) shall be responsible for maintaining control and accountability of sealed sources and conducting inventories of sealed sources at least every six months. The SS is also responsible for requesting Radiological Control Technicians (RCT) to perform leak test and radiation surveys, as appropriate, on all accountable radioactive sources. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technician** – The RCT shall be responsible for using and controlling all sealed radioactive sources as specified in this procedure, including maintaining positive control (i.e., continuous possession, line of sight) over all sealed radioactive sources in use as defined in this procedure. The RCT shall also notify the SS of suspected physical damage to a sealed radioactive source or of lost sealed sources

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Sealed Radioactive Source** - A radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layer(s) of nonradioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material. Sealed radioactive sources do not include reactor fuel elements, nuclear explosive devices, and radioisotope thermoelectric generators.

**Source Leak Test** - A test to determine if a sealed radioactive source is leaking radioactive material.

## 6.0 PROCEDURE DETAILS

### 6.1 GENERAL REQUIREMENTS

#### 6.1.1 SOURCE CONTROLS

The acquisition and receipt of radioactive sources must be approved by the SPM or designee. After receiving approval from the SPM or designee, sources may be procured and accepted. Receipt surveys are not required for exempt sources. Once the source has been accepted, it will be entered into the source inventory and placed in the approved storage location. The SPM or designee is responsible for assuring and performing proper labeling, inventory, and leak testing.

The SPM or designee assures that source storage locations meet the requirements of this procedure and is responsible for the proper routine source use functions of source storage and source sign out when removed from storage. An alternate may be designated to assist in these responsibilities. When not in use or when authorized users are not present, sources will be stored in a locked cabinet. This cabinet will be posted as Radioactive Material.

Sealed radioactive sources will be used, handled, and stored in a manner commensurate with the hazards associated with operations involving sources. Only users authorized by the SPM or designee may sign radioactive sources out of storage locations. This will be done using the Radioactive Source Sign-Out Log. This log will consist of a bound journal with numbered pages. This is not required when sources are being used in the area where the sources are stored. Sources should only be removed

from the storage location when needed to perform approved activities. Once these activities have been performed, sources should be immediately returned to the storage location.

### 6.1.2 INVENTORY

Each accountable and exempt sealed radioactive source will be inventoried at intervals not to exceed six months using the Source Inventory Log (Attachment 1). The inventory will:

- Establish physical location of each sealed radioactive source;
- Verify the presence and adequacy of associated postings and labels; and
- Establish the adequacy of storage locations, containers, and devices.

An accountable sealed radioactive source is not subject to periodic source leak testing if that source has been removed from service. Such sources will be stored in a controlled location, subject to periodic inventory at intervals not to exceed six months, and subject to source leak testing prior to being returned to service.

An accountable sealed radioactive source is not subject to periodic inventory and source leak test if that source is located in an area that is unsafe for human entry or otherwise inaccessible. This determination will be made by the SPM or designee.

## 7.0 RECORDS

Sealed source records, including procurement records, survey records, and lists of authorized sealed source users will be retained.

## 8.0 REFERENCES

<i>Number</i>	<i>Title</i>
10 CFR 20	<i>Standards for Protection Against Radiation</i>

## 9.0 ATTACHMENTS

Attachment 1, Source Inventory Log

**Source Inventory Log**

Source Model	Serial Number	Nuclide	Activity	Storage Location	Leak Test Date/Result	Storage Adequate? (yes/no)	Posting and Labeling Correct? (yes/no)	Custodian Initials

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_

# Standard Operating Procedure

## Occurrence Reporting

SOP 024

Revision 1

Prepared By:

Lawson Bailey  
Project Health Physicist

3/16/2012  
Date

Approved By:

Eric J. Alkender  
Project Radiation Safety Officer

3/16/2012  
Date

**REVISION HISTORY**

<i>Revision (Date)</i>	<i>Rev. No</i>	<i>Prepared By</i>	<i>Description of Changes</i>	<i>Affected Pages</i>
March 16, 2012	0	L. Bailey	Final Issue	All

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## 1.0 PURPOSE

The purpose of this procedure is to provide guidance on notifications required for non-routine (therefore, “unusual”) events that may be encountered in the course of performing project functions during survey, characterization and remediation activities by Tetra Tech (Tt) and its subcontractors.

## 2.0 SCOPE

This procedure describes types of unusual events that could be encountered on site and notifications that shall be made by Tt staff and subcontractor personnel.

This procedure describes the requirements for handling non-routine operations, but is not intended to supersede any regional or site specific operational emergency plans as a result of emergencies of national or regional significance. Additionally, this document does not supersede contingency plans developed under CERCLA.

## 3.0 MAINTENANCE

The Project Health Physicist (PHP) is designated the procedure owner and is responsible for updating this procedure.

## 4.0 RESPONSIBILITIES

The following personnel (or their qualified designee) will be directly involved with the procedures discussed herein.

**Project Radiation Safety Officer** – The PRSO has the authority to control all radiation safety onsite. All changes to procedures require approval by the PRSO. All unusual events shall be reported to the PRSO, who will report the events to Radiological Affairs Support Office (RASO).

**Project Health Physicist** – The PHP is responsible for notifying the PRSO of any unusual events during radiological operations. The PHP is also responsible for ensuring that subcontractors are implementing this procedure.

**Site Project Manager** – The Site Project Manager (SPM) is responsible for ensuring that all personnel are familiar with this procedure, adequately trained in the use of this procedure and have access to a copy of this procedure. The SPM is responsible for ensuring that the conditions of this procedure are complied with during all project operations. Additionally, the SPM is responsible for notifying the PHP on any unusual events as described in this procedure.

**Site Supervisor** – The Site Supervisor (SS) shall be responsible for assisting in the assignment of personnel that will perform the tasks required by this procedure. The SS is responsible for ensuring that RCTs implement and use this procedure. The SS will ensure that personnel under their cognizance observe proper precautions when using this procedure.

**Radiological Control Technician** – The RCT shall be responsible for the performance of the requirements of this procedure and documentation of work performed. The RCT shall ensure compliance with this and any other referenced procedure.

## 5.0 DEFINITIONS AND ABBREVIATIONS

**Anomaly** - Reading or result that appears to be an outlier in the professional judgment of the SPM, SS, or RCT. or survey results that are above investigation levels or outside the range or distribution of other measurements within a survey area.

**Contamination** – Deposition of radioactive material in any place it is not desired. Contamination may be due to the presence of alpha particle, beta particle or gamma ray emitting radionuclides.

## 6.0 PROCEDURE DETAILS

### 6.1 UNUSUAL EVENTS

Radiation Protection personnel involved in an unusual event should take the appropriate immediate initial actions in accordance with procedures, experience, training, and the professional judgment of Project Management and RCTs to minimize the hazards to personnel, facilities equipment, and the environment.

The following is a list of other examples of events that would require notification to SPM.

- Increasing or unanticipated dose or activity rates
- Releases of radioactive material to the environment.
- Transportation incidents/accidents.
- Personnel contamination
- Uncontrolled radioactive material found to exist outside radiological controlled areas
- Airborne radioactivity results which indicate that respiratory protection should have been worn but was not worn.
- Posting of any areas as airborne radioactivity area, high radiation area, or very high radiation area.
- Missing, lost, or otherwise not accounted for radioactive source.
- Survey or sample anomalies or non-conformances
- Deviations from work plans or procedure violations
- Uncontrolled radioactive or other hazardous material
- Fire in contaminated area
- Personnel injuries
- Regulatory visits (such as by the NRC or other regulatory agencies)
- Breaches in security

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**Unusual Event Notifications**

Revision 1 – Page 6 of 6

- Non-regulatory third-party individuals, including members of the media, who request access to the site or ask questions

**6.2 NOTIFICATIONS**

If any of the events listed in Section 6.1 occur, or if other events occur that site personnel feel need to be reported occurs, personnel will notify the SS and/or SPM immediately. The SPM will immediately notify the PHP and PRSO. The PRSO will notify RASO and the RPM.

Notification should be made by telephone. If none of these individuals is available, the RCT will leave a voice mail and confirmatory e-mail describing the anomaly and follow up with a call to the appointed designee, if any.

For large events, immediate notification is required.

For moderate and small events, notification within 24 hours is required.

Classification of the magnitude of these events will be made in the professional judgment of the PHP and PRSO.

For any event in which notification is required, a written occurrence report must be submitted to RASO within 30 days

**7.0 RECORDS**

Occurrence reports shall be written and submitted to RASO as required by Section 6.2. Copies of each report shall be sent to the PHP and maintained on site in project records. Results of personnel, radiation, contamination and airborne activity surveys, and Radiation Work Permits generated in response to a release of radioactive material shall be maintained with project quality records.

**8.0 REFERENCES**

None

**9.0 ATTACHMENTS**

None



**TETRA TECH, INC**

**Procedure No: RP-OP-017 Rev 0**

**OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER**

Approved By:

Lauson Bailey  
Project Health Physicist

3/16/2012  
Date

**OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER****1.0 PURPOSE**

This procedure provides instructions for the operation of the Ludlum 2929 Dual Scaler used in support of radiological operations. This instrument is used primarily for alpha and beta radioactivity measurements of dry filter media (surface swipes, dried water, and air samples) and soil.

**SCOPE**

This procedure applies to the use of the Ludlum 2929 Dual Scaler, used in conjunction with the Ludlum Model 43-10-1 alpha-beta sample counter. This procedure does not apply to other filter sample counting equipment.

The following activities are described in this procedure:

4.1 Pre-Operational Checks

4.2 Initial Source Check

4.3 Background Check

4.4 Source Check

4.5 Instrument Use

4.6 Determination of Instrument Minimum Detectable Activity

**2.0 REFERENCES**

Instruction Manual, Ludlum Model 2929 Dual Channel Scaler, Ludlum Measurements, Inc.

Instruction Manual, Ludlum Model 43-10-1 Alpha-Beta Sample Counter, Ludlum Measurements, Inc.

**3.0 GENERAL**

The Ludlum Model 43-10-1 is an alpha-beta sample counter capable of holding up to a 2-inch diameter filter or planchet. The sample drawer, when fully closed strikes a micro switch to allow high voltage (HV) to be applied to the photomultiplier tube (PMT). The sample drawer is locked in the closed position by rotation of a slide lever mounted on the side of the instrument. The Ludlum Model 2929 dual channel scaler provides the necessary circuitry for simultaneous alpha-beta counting.

ZnS (Ag) is used for alpha radiation detection and a plastic scintillator material for beta radiation detection. The scintillation material is covered by 0.4 mg/cm<sup>2</sup> metalized mylar to reduce light response (excessive background).

**3.1 EQUIPMENT**

- Ludlum Model 2929 Dual Channel Scaler
- Ludlum Model 43-10-1 Alpha-Beta Sample Counter
- Check sources

**OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER****3.2 SAFETY CONSIDERATIONS**

Due to the presence of 110V AC, electrical shock is a potential hazard if proper care is not exercised during the operation of the equipment.

Use care when handling radioactive sources or samples to prevent personal contamination or contamination of the sample tray or detector.

**3.3 RESPONSIBILITIES**

3.3.1 The Site Supervisor (SS) is responsible for:

- Implementing this procedure.
- Ensuring that RCTs are qualified to perform this procedure.

3.3.2 Radiological Control Technicians (RCTs) are responsible for:

- Following this procedure in the performance of duties associated with the Ludlum 2929.
- Notifying the SS and with concurrence, initiating a procedure change notice when an error in this procedure is identified or when an improvement in radiation protection methods can be made.

**3.4 PREREQUISITES**

3.4.1 Only thin samples of diameter less than 2 inches may be counted.

3.4.2 Instrument is within its annual calibration cycle

**3.5 RECORDS**

3.5.1 Survey records are generated during the implementation of this procedure.

3.5.2 Records are prepared by RCTs and reviewed and approved by the SS. Completed and approved records will be maintained in accordance with project requirements.

**3.6 PRECAUTIONS AND LIMITATIONS**

3.6.1 The Ludlum Model 2929 is semi-portable and requires 110-volt AC to operate.

3.6.2 Only thin samples of diameter no larger than 2 inches (5 cm) may be counted.

**3.7 REVISIONS**

This procedure shall be reviewed every three years, or as appropriate.

**3.8 OTHER**

Not Applicable

**3.9 ATTACHMENTS**

Attachment 1 Control Chart Construction

Attachment 2 Sample Control Chart

Attachment 3 Daily Response Check Form

**OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER****4.0 PROCEDURE****4.1 Basic Operation**

- 4.1.1 Connect the probe to the "DETECTOR" Input Connection located on the front of the instrument using a coax cable with "C" connectors.
- 4.1.2 Turn the instrument on by placing the toggle switch in the "ON" position. Note that the needle on the "KILOVOLTS" meter is registering greater than zero (0) volts.
- 4.1.3 Check that the "HV" dial is set to the number established during instrument calibration.

**4.2 Sample Loading**

- 4.2.1 Release the sample drawer by turning the lock handle toward the front of the instrument.
- 4.2.1 Slide the sample drawer forward.
- 4.2.2 Place the sample in the center of the drawer and close the drawer slowly.
- 4.2.3 Lock the drawer by turning the lock handle toward the back of the instrument.

**NOTE**

Unless the drawer is locked, high voltage will not be supplied to the probe and therefore no counts will be registered. The scaler will cycle through the counting process, regardless of the drawer lock position.

**4.3 Timed Counting**

- 4.3.1 Set the counting time in minutes using the thumbwheel switches and one of the three multiplier settings on the range knob. (For example, for a 10 minute count, set the thumbwheel to 10, and the multiplier to X1.)
- 4.3.2 Press the "Count" button. The red lamp located next to the "Count" button should illuminate.
- 4.3.3 When the red lamp goes out, the count is finished.

**NOTE**

Use of the audio speakers (controlled by the knobs "ALPHA VOL" and "BETA-GAMMA VOL") is optional. Both may be set to minimum volume by rotating the knobs to the full counter-clockwise position.

**4.4 Source Response Testing**

- 4.4.1 Creating a Control Chart

**OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER****NOTE**

A control chart need only be established for the type of radiation that will be evaluated during the survey. If the survey is only being performed to evaluate alpha contamination, a beta control chart need not be constructed.

- 4.4.1.1 Obtain a 20 minute background count for both the alpha and beta-gamma channels and divide the result by 20 to obtain the background cpm.
- 4.4.1.2 Record the results on Attachment 1.
- 4.4.1.3 Using a NIST traceable alpha source or a stable artifact, obtain 20 one (1) minute counts. Record each of the measurements on Attachment 1.

**NOTE**

Since the daily source response checks can introduce source geometry errors, the source should be removed and replaced for each of the 20 one minute counts.

- 4.4.1.4 Subtract the background cpm from each of the measurements to determine the corrected measurement. Record the results on Attachment 1.
- 4.4.1.5 Determine and record the mean and standard deviation for the corrected measurements.
- 4.4.1.6 Construct a control chart showing the mean as a constant with respect to time. Construct parallel lines for  $\pm 2\sigma$  (warning level) and  $\pm 3\sigma$  (out of control level). A sample control chart is provided as Attachment 2.

**NOTE**

A spreadsheet program such as Excel may be used to construct the control chart described in Step 4.4.1.6 above.

- 4.4.1.7 Repeat the steps 4.4.1.3 – 4.4.1.6 with a NIST traceable beta source or a stable artifact.
  - 4.4.1.8 Record the values of “Mean –  $2\sigma$ ” and “Mean +  $2\sigma$ ” for both alpha and beta on Attachment 3 under “Acceptance Criteria”.
- 4.4.2 Daily Response Check
- 4.4.2.1 At least daily, perform a source check for both the alpha and beta-gamma channels, using the same source-detector geometry as for control chart construction.
  - 4.4.2.2 Perform a 20 minute background count and a single 1 minute count using the alpha source. Repeat the 1 minute count using the beta source. Record the results on Attachment 3.
  - 4.4.2.3 Compare the response in each channel against the control chart.



## OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER

4.4.2.4 If the results are within the  $\pm 2\sigma$  bracket, the instrument is acceptable for use. Data obtained between this check and the previous acceptable check are considered "valid" for the purposes of satisfying project requirements.

4.4.2.5 If the result is within the band  $\pm 2\sigma$  and  $\pm 3\sigma$ , the check should be repeated.

### **NOTE**

Due to statistical considerations alone, you would predict that 1 out of every 20 measurements would fall outside of the  $\pm 2\sigma$  bracket.

4.4.2.6 If the repeat measurement is within the  $\pm 2\sigma$  bracket, the instrument is acceptable for use. If the repeat measurement does not fall within the  $\pm 2\sigma$  bracket notify the survey team leader.

4.4.2.7 If the result is outside of the  $\pm 3\sigma$  line, notify the survey team leader.

## 4.5 Efficiency Determination

4.5.1 For both the alpha and beta NIST traceable sources, used in constructing the control chart, determine the  $2\pi$  emission rate (in particles per minute), making any necessary decay corrections. This information should be obtained from the source certificate.

4.5.2 Calculate the alpha counting efficiency by dividing the mean (in cpm) obtained in Step 4.4.1.5 by the  $2\pi$  emission rate. Record the result on Attachment 3.

4.5.3 Repeat the calculation for the beta counting efficiency.

### **NOTE**

This efficiency will be used until such time as a new control chart is constructed.

## 4.6 Determination of Minimum Detectable Activity (MDA)

4.6.1 Determine the instrument's minimum detectable alpha activity on a daily basis using the following formula:

$$MDA = \frac{3 + 3.29 \sqrt{R_b t_g \left( 1 + \frac{t_g}{t_b} \right)}}{(Efficiency)(t_g)}$$

where:

$R_b$  = background count rate, cpm

$t_g$  = sample counting time, min

$t_b$  = background counting time, min

efficiency is expressed as cpm/dpm

**OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER**

4.6.2 Repeat step 4.6.1 for beta. Record both results on Attachment 3.

**4.7 Sample Counting**

4.7.1 Load the sample into the sample drawer in accordance with Section 4.2.

4.7.2 Count the sample for one (1) minute.

4.7.3 Calculate sample activity, in dpm, by subtracting the background count rate and dividing the result by the efficiency.

4.7.4 Record the activity of the sample on the appropriate survey form.

4.7.5 If the sample activity is less than the MDA, record "<MDA" as the sample activity.

## CONTROL CHART CONSTRUCTION

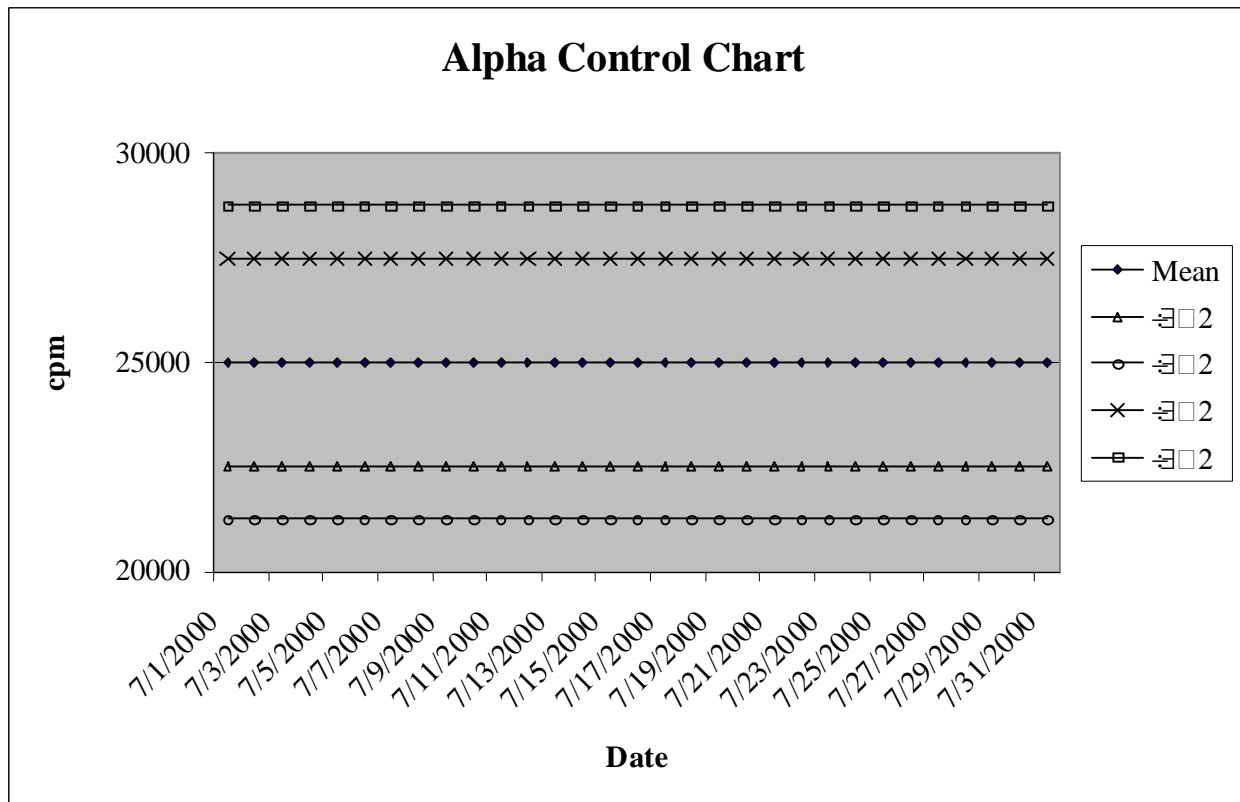
Instrument Serial # \_\_\_\_\_ Probe Serial # \_\_\_\_\_

High Voltage Setting \_\_\_\_\_ V

Alpha Source Serial # \_\_\_\_\_ Beta Source Serial # \_\_\_\_\_

	Alpha				Beta			
	20 minute bkgd count				20 minute bkgd count			
	Bkgd count rate, cpm				Bkgd count rate, cpm			
Measurement, n	Gross Counts (cpm)	Net Counts (cpm), $x_i$	$x_i - x_m$	$(x_i - x_m)^2$	Gross Counts (cpm)	Net Counts (cpm), $x_i$	$x_i - x_m$	$(x_i - x_m)^2$
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Mean, $x_m$								
$\sum (x_i - x_m)^2$								
$\sum (x_i - x_m)^2 / (n-1)$								
$(\sum (x_i - x_m)^2 / (n-1))^{1/2}, \sigma$								

## SAMPLE CONTROL CHART



## DAILY RESPONSE CHECK FORM

Instrument Serial # \_\_\_\_\_ Probe Serial # \_\_\_\_\_

High Voltage Setting \_\_\_\_\_ V

## Acceptance Criteria

Alpha Source Check: \_\_\_\_\_ to \_\_\_\_\_ cpm on Source Serial # \_\_\_\_\_

Beta Source Check: \_\_\_\_\_ to \_\_\_\_\_ cpm on Source Serial # \_\_\_\_\_

Efficiencies: Alpha \_\_\_\_\_ Beta \_\_\_\_\_ cpm/dpm

MDA:      Alpha \_\_\_\_\_      Beta \_\_\_\_\_      dpm/100cm<sup>2</sup>

[illegible]



**TETRA TECH, INC**

**Procedure No: RP-OP-025 Rev 0**

**OPERATION OF THE LUDLUM MODEL 2221**

Approved By:

Lawson Bailey  
Project Health Physicist

2/16/2012  
Date



## **OPERATION OF THE LUDLUM MODEL 2221**

### **1.0 PURPOSE**

This procedure provides guidance to the Site Supervisor (SS) and Radiological Control Technicians (RCT) for the calibration, maintenance, pre-operational checks, and operational use of the Ludlum Model 2221 Ratemeter/Scaler.

### **SCOPE**

This Procedure applies to the SS and the RCTs who are responsible for performing the pre-operational checks and operational use of the Ludlum Model 2221 Ratemeter/Scaler as part of their job responsibilities.

The following activities are described in this procedure:

- 4.1 Pre-Operational Checks
- 4.2 Initial Source Check
- 4.3 Background Check
- 4.4 Source Check
- 4.5 Instrument Use

### **2.0 REFERENCES**

10 CFR 20, *Standards for Protection Against Radiation*  
SOP 006, Radiation and Contamination Surveys  
Ludlum Model 2221 Ratemeter/Scaler Instruction Manual

### **3.0 GENERAL**

The Ludlum Model 2221 portable ratemeter/scaler is a self contained counting instrument designed for operation with scintillation, proportional or G-M detectors. The unit is powered by four flashlight (D cell) batteries. The unit has a four decade linear and log ratemeter and a six digit LCD readout for for the scaler and digital ratemeter.

#### **3.1 EQUIPMENT**

- Ludlum Model 2221 Ratemeter/Scaler with proportional or G-M detector
- Radiological Survey Forms.

#### **3.2 SAFETY CONSIDERATIONS**

Operating Range 5 to 122 degrees F.

**OPERATION OF THE LUDLUM MODEL 2221****3.3 RESPONSIBILITIES****3.3.1** The SS is responsible for:

- Implementation of this procedure.
- Ensuring that RCTs are qualified to perform this procedure.
- Ensuring that all survey documentation is reviewed.
- Verifying that all documentation generated in support of this procedure meets the requirements of this procedure prior to approval.
- Ensuring the documentation is properly filed and protected

**3.3.2** RCTs are responsible for:

- Complying with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological surveys. Complying with entry requirements for the areas to be surveyed.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change.

**3.4 PREREQUISITES****3.4.1** The RCT should review available survey data if unfamiliar with the area or current radiological conditions.**3.4.2** Survey numbers are sequentially numbered. The survey number should be on all survey documentation.**3.5 RECORDS**

Survey records are generated during implementation of this procedure. Records include the following forms:

- Radiological Survey Form.
- Radiological Survey Continuation Form.

Records are maintained in accordance with the TtNUS records management policy and applicable program and project requirements. The record copies are filed on site for the duration of the project.



## **OPERATION OF THE LUDLUM MODEL 2221**

Handwritten survey documentation shall be completed in permanent black or blue-black ink only. Changes to survey documentation shall only be made to the record copy and shall be made in black or blue ink and shall be made with a single line, initialed and dated.

### **3.6 PRECAUTIONS AND LIMITATIONS**

- 3.6.1 When entering areas of unknown radiation levels, the highest scale available on the survey instrument should be selected prior to entry and the instrument window should be open.
- 3.6.2 To avoid contaminating an instrument case, instruments may be placed in plastic bags or similar devices.

### **3.7 REVISIONS**

This procedure shall be reviewed every three years, or as appropriate.

### **3.8 ATTACHMENTS**

Attachment 1 – Control Chart Construction

Attachment 2 – Daily Response Check Form

## **4.0 PROCEDURE**

### **4.1 INSTRUMENT CALIBRATION**

- 4.1.1 The SS ensures the instrument is maintained calibrated by qualified personnel:
  - annually;
  - after any repair, maintenance, or modification which has affected the calibration;
  - after any exposure to temperature extremes or physical conditions which have affected the calibration.
- 4.1.2 The Model 2221 Ratemeter/Scaler will be calibrated with a specific type of probe, either proportional or G-M. The calibration is valid only for the type of probe specified in the calibration certificate. The calibration will establish operating voltage plateaus for alpha and alpha plus beta for gas flow proportional detectors. The high voltage setting, threshold value and window settings will be established in the calibration documentation.

**OPERATION OF THE LUDLUM MODEL 2221**

- 4.1.3 Prior to initial use of a Model 2221 Ratemeter/Scaler with detector, The SS shall establish a baseline source check of the instrument. An alpha or beta source (does not require NIST traceability, but must be stable) is positioned in a reproducible geometry below the detector. Prior to establishing the baseline, a 10 minute background count must be obtained. Source selection should be of sufficient strength to make the background counts a small fraction of the source counts. The baseline response is then determined by taking a minimum of 20 one minute scaler readings, removing and replacing the source between each reading. The average value of the 20 readings (net counts above background) is the baseline reading for that instrument. The results are documented in attachment A. A separate baseline will be performed for both alpha and beta sources for each instrument.

**4.2 INSTRUMENT REPAIR AND MAINTENANCE**

- 4.2.1 The SS ensures that instruments that have been identified as out-of-service or requiring maintenance or repair are repaired and/or maintained by qualified personnel.
- 4.2.2 The instrument should not be stored over 30 days without removing the batteries.
- 4.2.3 The instrument operates on two "D" cell batteries, which should be removed and the battery contacts cleaned of any corrosion at least every three months.

**4.3 INSTUMENT PRE-OPERATIONAL CHECKS**

- 4.3.1 Pre-operational checks are performed daily or prior to use for instruments that are not used daily.
- 4.3.2 Check the battery: turn the power switch to "ON," press and hold the "BAT" button. Observe the LCD display. If greater than 4.8 volts charge is indicated, proceed with pre-operational checks. If 4.8 volts or less is indicated, or if the display flashes or consists of only decimal points, then replace the batteries and repeat step 4.3.1.2.
- 4.3.3 Check the high voltage: press and hold the "HV" button. If the displayed value is within 5% of the standard (see calibration sticker on meter or instrument calibration record), proceed with pre-operational checks. Otherwise, tag the instrument "Out-of-Service" and notify the Site Supervisor.
- 4.3.4 Check threshold: press and hold the "THR" button. If the displayed value is within 5% of the standard (see calibration sticker on meter or instrument calibration record), proceed with pre-operational checks. Otherwise tag the instrument "Out-of-Service" and notify the Site Supervisor.
- 4.3.1 Perform the daily source check:
- Obtain the appropriate source(s)

**OPERATION OF THE LUDLUM MODEL 2221**

- Place the source in the same geometry relative to the detector probe as used to establish baseline reading. Obtain a 1 minute count of the each source. Both alpha and beta sources must be used if the instrument is to be used in both modes during the day.
- Obtain a 1 minute background count
- Record results on Attachment B. Compare results to control chart ranges. If the value is within  $2\sigma$  of the mean, the instrument passes and may be placed in service. If the source check is between  $2\sigma$  and  $3\sigma$ , repeat the source check. If the second falls outside of  $2\sigma$ , the source check fails. Any result outside  $3\sigma$  will cause the instrument to fail. If the instrument fails, tag the instrument "Out-of-Service" and notify The SS.

**4.4 INSTRUMENT OPERATIONAL USE**

- 4.4.1** Determine the background radioactivity levels based on reference area surveys. Consult The SS if background values are nor readily available.
- 4.4.2** Perform a scan survey by moving the detector, at a predetermined distance and rate of speed over the surface of the item or material being monitored. Scan speed and survey distance will be established in survey work plans.
- 4.4.2** Areas of detected radioactivity in excess of investigation levels during scan surveys should be marked for direct measurement evaluations.
- 4.4.3** Following the completion of a scan survey, perform a direct measurement for each area identified in the survey work plan and at the locations noted in step 4.4.2.
- 4.4.4** Direct reading instrument measurements are obtained by placing the detector against the surface (i.e., at a predetermined distance) or in the media being surveyed for a fixed amount of time. Direct measurements shall be taken using the scaler mode for the predetermined count time. Count time requirements are in the survey work plan.
- 4.4.5** All survey data collected shall be documented on the Radiological Survey Forms contained in SOP 006, Radiation and Contamination Surveys.

### CONTROL CHART CONSTRUCTION

Instrument Serial # \_\_\_\_\_ Probe Serial # \_\_\_\_\_

HV Settings Alpha \_\_\_\_\_ V Alpha + Beta \_\_\_\_\_ V

Alpha Source Serial # \_\_\_\_\_ Beta Source Serial # \_\_\_\_\_

	Alpha				Beta			
	10 minute bkgd count				10 minute bkgd count			
	Bkgd count rate, cpm				Bkgd count rate, cpm			
Measurement, n	Gross Counts (cpm)	Net Counts (cpm), $x_i$	$x_i - x_m$	$(x_i - x_m)^2$	Gross Counts (cpm)	Net Counts (cpm), $x_i$	$x_i - x_m$	$(x_i - x_m)^2$
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Mean, $x_m$								
$\sum (x_i - x_m)^2$								
$\sum (x_i - x_m)^2 / (n-1)$								
$(\sum (x_i - x_m)^2 / (n-1))^{1/2}, \sigma$								

## DAILY RESPONSE CHECK FORM

Instrument Serial # \_\_\_\_\_ Probe Serial # \_\_\_\_\_

High Voltage Setting \_\_\_\_\_ V

### Acceptance Criteria

Alpha Source Check: \_\_\_\_\_ to \_\_\_\_\_ cpm on Source Serial # \_\_\_\_\_

Beta Source Check: \_\_\_\_\_ to \_\_\_\_\_ cpm on Source Serial # \_\_\_\_\_

Efficiencies: Alpha \_\_\_\_\_ Beta \_\_\_\_\_ cpm/dpm

[illegible]

Page \_\_\_\_ of \_\_\_\_

**DAILY RESPONSE CHECK FORM (CONT.)**[illegible]



**TETRA TECH, INC**

**Procedure No: RP-OP-026 Rev 0**

**OPERATION OF THE LUDLUM MODEL 19**

Approved By:

Lawson Bailey  
Project Health Physicist

3/16/2012  
Date

**OPERATION OF THE LUDLUM MODEL 19****1.0 PURPOSE**

This procedure provides guidance to the Site Supervisor (SS) and Radiological Control Technicians (RCT) for the calibration, maintenance, pre-operational checks, and operational use of the Ludlum Model 19 Micro-R Meter.

**SCOPE**

This Procedure applies to the SS and RCTs who are responsible for performing the pre-operational checks and operational use of the Ludlum Model 19 Micro-R Meter as part of their job responsibilities.

The following activities are described in this procedure:

4.1 Pre-Operational Checks

4.2 Initial Source Check

4.3 Background Check

4.4 Source Check

4.5 Instrument Use

**2.0 REFERENCES**

10 CFR 20, *Standards for Protection Against Radiation*

SOP 006, Radiation and Contamination Surveys

Ludlum Model 19 Micro-R Meter Instruction Manual

**3.0 GENERAL**

The Ludlum Model 19 Micro-R Meter utilizes an internally mounted 1" by 1" NaI(Tl) scintillator for locating and measuring low-level (near background) gamma radiation. The unit has a range up to 5000  $\mu\text{R/hr}$  (5 mR/hr).

**3.1 EQUIPMENT**

- Ludlum Model 19 Micro-R Meter
- Radiological Survey Forms.

**3.2 SAFETY CONSIDERATIONS**

Although this meter will operate at very high ambient temperatures, battery seal failure can occur at temperatures as low as 100 degrees F.

**OPERATION OF THE LUDLUM MODEL 19****3.3 RESPONSIBILITIES****3.3.1** The SS is responsible for:

- Implementation of this procedure.
- Ensuring that RCTs are qualified to perform this procedure.
- Ensuring that all survey documentation is reviewed.
- Verifying that all documentation generated in support of this procedure meets the requirements of this procedure prior to approval.
- Ensuring the documentation is properly filed and protected

**3.3.2** RCTs are responsible for:

- Complying with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological surveys. Complying with entry requirements for the areas to be surveyed.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change.

**3.4 PREREQUISITES****3.4.1** The RCT should review available survey data if unfamiliar with the area or current radiological conditions.**3.4.2** Survey numbers are sequentially numbered. The survey number should be on all survey documentation.**3.5 RECORDS**

Survey records are generated during implementation of this procedure. Records include the following forms:

- Radiological Survey Form.
- Radiological Survey Continuation Form.

Records are maintained in accordance with the TtNUS records management policy and applicable program and project requirements. The record copies are filed on site for the duration of the project.



## **OPERATION OF THE LUDLUM MODEL 19**

Handwritten survey documentation shall be completed in permanent black or blue-black ink only. Changes to survey documentation shall only be made to the record copy and shall be made in black or blue ink and shall be made with a single line, initialed and dated.

### **3.6 PRECAUTIONS AND LIMITATIONS**

- 3.6.1 When entering areas of unknown radiation levels, the highest scale available on the survey instrument should be selected prior to entry and the instrument window should be open.
- 3.6.2 To avoid contaminating an instrument case, instruments may be placed in plastic bags or similar devices.

### **3.7 REVISIONS**

This procedure shall be reviewed every three years, or as appropriate.

### **3.8 ATTACHMENTS**

None

## **4.0 PROCEDURE**

### **4.1 INSTRUMENT CALIBRATION**

The SS ensures the instrument is maintained calibrated by qualified personnel:

- annually;
- after any repair, maintenance, or modification which has affected the calibration;
- after any exposure to temperature extremes or physical conditions which have affected the calibration.

Prior to initial use of a Model 19, the SS shall establish a baseline source check of the instrument. A gamma source (does not require NIST traceability, but must be stable) is positioned in a reproducible geometry against or near the survey meter. A baseline response is determined by taking 10 readings, removing and replacing the source between each reading. The average value of the 10 readings is the baseline reading for that instrument.

### **4.2 INSTRUMENT REPAIR AND MAINTENANCE**

**OPERATION OF THE LUDLUM MODEL 19**

- 4.2.1 The SS ensures that instruments that have been identified as out-of-service or requiring maintenance or repair are repaired and/or maintained by qualified personnel.
- 4.2.2 The instrument should not be stored over 30 days without removing the batteries.
- 4.2.3 The instrument operates on two "D" cell batteries, which should be removed and the battery contacts cleaned of any corrosion at least every three months.

**4.3 INSTRUMENT PRE-OPERATIONAL CHECKS**

- 4.3.1 Pre-operational checks are performed daily or prior to use for instruments that are not used daily.
- 4.3.2 Battery Check - Place the selector switch in the "25" position. Depress the "BAT" pushbutton switch and ensure that the meter needle falls within the "BAT OK" marks.
- 4.3.3 Background check – Place the selector switch in the "25" position. Background reading should be between 5 and 15  $\mu\text{R/hr}$ .
- 4.3.4 Source check – place the source used to establish the instrument baseline in the same geometry as that used to establish the baseline. The reading obtained must be within 20% of the baseline reading.
- 4.3.5 Failure of any preoperational test requires that the instrument be removed from service for repair

**4.4 INSTRUMENT OPERATIONAL USE**

- 4.4.1 The Model 19 is used to determine radiation readings, Allow needle to stabilize in a location prior to determining radiation level.
- 4.4.2 Record survey results on Radiological Survey Forms contained in SOP 006, Radiation and Contamination Surveys.

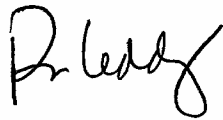
**Millennium Services, Inc.**

**Survey Procedure**

SCM-OPS-01, Rev. 0

PSPC Purging

Effective Date: 01/17/08

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Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08

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## 1. Purpose

This procedure details the requirements for purging a Position Sensitive Proportional Counter (PSPC) using P-10 gas for use with the Surface Contamination Monitor (SCM).

## 2. Scope

This procedure applies to any PSPC configuration for use with the SCM.

## 3. Responsibilities

### 3.1 Project Manager

3.1.1 Reads and becomes familiar with this procedure.

3.1.2 Has successfully completed SCM Level I training for the SCM model being used.

### 3.2 Operator

3.2.1 Reads and becomes familiar with this procedure before performing measurements.

3.2.2 Has successfully completed SCM Level I training for the SCM model being used.

## 4. Definitions and Acronyms

**Table 1: Definitions and Acronyms**

Item	Description
cc/min	cubic centimeters per minute
HV	High-voltage
LV	Low-voltage
P-10 Gas	90% argon / 10% methane gas mixture used in PSPC. Ultra high purity quality is recommended.
psi	pounds per square inch
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity.
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.

## 5. Materials, Equipment, and Software

**Table 2: Materials, Equipment, and Software**

Item	Specification
SCM III Flow Meter	Non-Specific: Rotometer type graduated to 240 cc/min is typical. Note that purge flow rates will exceed the capacity of this flow meter, so flow must bypass the outlet flow meter during purge.
Gas Detector	Non-Specific: MSHA approved.
PSPC	Typical lengths include 1 and 2 meters and can be constructed using metal or plastic. Custom lengths can be manufactured based on project requirements.
Purge Station	A dedicated purge station can be used rather than an SCM. The purge station requires P-10 gas, a regulator, a flow meter with flow-in and flow-out gauges, two-way gas valve, and tubing.
SCM III Regulator	A regulator that has controls to adjust the primary and secondary side pressure. Compatible with P-10 cylinders.
SCM IV Lite Regulator	A fixed regulator with integral flow control, allowing the operator to set an outlet flow rate. The assembly is also equipped with a valve that will not allow the bottle pressure to drop below 50psi, so that the bottle does not require evacuation prior to refill.
SCM IV Digital Flow Meter	
SCM	
Tape, Cellophane	Non-Specific: Industry standard.

## 6. Procedure

- 6.1 For an SCM Model IV, proceed to step 6.3.
- 6.2 SCM Model III
  - 6.2.1 Connect the gas source to the PSPC using the color coded tubing. The red connection corresponds to the inlet of the PSPC and the blue connection corresponds to the outlet of the PSPC.
  - 6.2.2 Orient the PSPC vertically so that the inlet of the PSPC is at the bottom of the detector.
  - 6.2.3 Open the valve on P-10 gas bottle. Ensure there is at least a primary inlet pressure of 500 psi as indicated on the regulator.
  - 6.2.4 Turn the handle on the two-way purge valve, located between the PSPC outlet connector (blue) and the outlet flow gauge, such that the handle is turned in the direction of the outlet flow gauge. Visually confirm the ball valve is closed.
  - 6.2.5 Turn the knob on the inlet flow meter until the gauge reads 100 cc/min and wait for the outlet flow to stabilize. If the outlet flow meter does not rise or is significantly less than the inlet flow meter, there is a gas leak.
  - 6.2.6 Locate any leaks using a gas detector. If a leak occurs on mylar of the PSPC, attempt to repair using cellophane tape with the following conditions:
    - Up to 10% of the active surface area of the mylar may be covered with cellophane tape before the PSPC must be removed from service.
    - If cellophane tape covers more than 10% of any 100 cm<sup>2</sup> area of the PSPC, the PSPC must be removed from service.
  - 6.2.7 If a leak occurs anywhere other than the mylar, contact the Project Manager.
  - 6.2.8 Once adequate flow has been determined, turn the two-way purge valve 180 degrees to vent the PSPC outlet to atmosphere, and visually confirm the ball valve is open.
  - 6.2.9 Increase gas flow on the inlet flow gauge, until the indicator ball reaches the top of the tube, and then turn the knob one additional half turn.
  - 6.2.10 Check the regulator's secondary gauge and adjust as necessary to maintain 10 psi.

**Note: Always use the screen cover when purging a PSPC to minimize the potential for the mylar to stretch and/or pop.**

- 6.2.11 Purge approximately 15 minutes for a 2 m PSPC and 10 minutes for a 1 m PSPC.
- 6.2.12 Adjust the inlet flow meter to a reading between 50 and 100 cc/min and adjust the pressure on the regulator's secondary gauge to between 5 to 15 psi.
- 6.2.13 Turn the handle on the two-way purge valve such that the handle is turned in the direction of the outlet flow gauge. Visually confirm the ball valve is closed.
- 6.2.14 Re-verify that the reading on the outlet flow meter does not rise above or is significantly less than the outlet flow meter.

### 6.3 SCM Model IV

- 6.3.1 Connect the gas source to the PSPC using the color coded tubing. The red connection corresponds to the inlet of the PSPC and the blue connection corresponds to the outlet of the PSPC.
- 6.3.2 Orient the PSPC vertically so that the inlet of the PSPC is at the bottom of the detector.
- 6.3.3 Open the valve on P-10 gas bottle. Ensure there is at least a primary inlet pressure of 500 psi as indicated on the regulator.
- 6.3.4 Turn the dial the SCM4 Lite Regulator to the 1/8 setting and wait for the outlet flow to stabilize. If the digital flow meter does not nominally read 30 cc/min, there is a gas leak.
- 6.3.5 Locate any leaks using a gas detector. If a leak occurs on mylar of the PSPC, attempt to repair using cellophane tape with the following conditions:
  - Up to 10% of the active surface area of the mylar may be covered with cellophane tape before the PSPC must be removed from service.
  - If cellophane tape covers more than 10% of any 100 cm<sup>2</sup> area of the PSPC, the PSPC must be removed from service.
- 6.3.6 If a leak occurs anywhere other than the mylar, contact the Project Manager.
- 6.3.7 Turn the dial on the SCM4 Lite Regulator to the 2 to initiate detector purge

**Note: Always use the screen cover when purging a PSPC to minimize the potential for the Mylar to stretch and/or pop.**

- 6.3.8 Purge approximately 15 minutes for a 2 m PSPC and 10 minutes for a 1 m PSPC.
- 6.3.9 Turn the dial the SCM4 Lite Regulator to the 1/8 setting and wait for the outlet flow to stabilize
- 6.3.10 Re-verify that the digital flow meter has a nominal reading of 30 cc/min.

## **7. Acceptance Criteria**

The Project Manager will determine gas leak tolerance, i.e. the differential between the flow-in and flow-out rates.

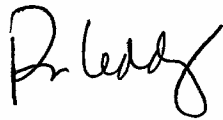
**Millennium Services, Inc.**

**Survey Procedure**

SCM-OPS-02, Rev. 0

PSPC Plateau Determination

Effective Date: 01/17/08

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Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08

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## **1.0 Purpose**

This procedure details the requirements for creating a high voltage (HV) plateau for a Position Sensitive Proportional Counter (PSPC) for use with Surface Contamination Monitor (SCM) Model III and IV.

## **2.0 Scope**

SCM must have a completed HV plateau determined annually, any time the electronics of the SCM have been altered or replaced as to make the determined alpha and/or beta operating voltage (OV) questionable. *Ensure that the HV plateau is conducted in where the temperature and pressure are similar to that of the project.*

## **3.0 Responsibilities**

### **3.1 Project Manager**

- 3.1.1 Reads and becomes familiar with this procedure.
- 3.1.2 Has successfully completed SCM Level I training for the SCM model being used.
- 3.1.3 Reviews documentation (Attachment A) to ensure HV plateau determination is performed according to this procedure and determines the appropriate alpha and beta OV.

### **3.2 Operator**

- 3.2.1 Reads and becomes familiar with this procedure before performing measurements.
- 3.2.2 Has successfully completed SCM Level I training for the SCM model being used.
- 3.2.3 Performs all measurements according to this procedure. Records data on Attachment A.

## 4.0 Definitions and Acronyms

**Table 1: Definitions and Acronyms**

Item	Description
HV	High-voltage
LV	Low-voltage
P-10 Gas	90% argon / 10% methane gas mixture used in PSPC. Ultra high purity quality is recommended.
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity.
OV	Operating voltage
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.
SRA	Shonka Research Associates, Inc.

## 5.0 Materials, Equipment, and Software

**Table 2: Materials, Equipment, and Software**

Item	Specification
Alpha and Beta Radioactive Sources	High count rate alpha and beta button sources, similar to the energy and type for the specific survey are recommended. A total count rate in excess of 10,000 counts per minute is recommended.
PSPC	Typical lengths include 1 and 2 meters and can be constructed using metal or plastic. Custom lengths can be manufactured based on project requirements.
SCM	Model III or IV.
Small Flat-Head Screwdriver	Jeweler's-sized screwdriver is required for adjusting SCM Model III electronics.

## 6.0 Procedure

- 6.1 Ensure the PSPC is purged per Reference 9.1. Note that step 6.2 can be completed while the PSPC is purging.
- 6.2 Ensure the SCM hardware is setup per Reference 9.2.

### 6.3 Construct HV Plateau

- 6.3.1 Record the SCM Serial Number, SCM Model, PSPC type, PSPC length, operator initials, and date on Attachment A.
- 6.3.2 Adjust the HV to 900 V. After a few seconds to allow the voltage to stabilize, adjust the HV to 1000 V.
- 6.3.3 Acquire a one-minute gross measurement across the full length of the PSPC.
- 6.3.4 Record the value on Attachment A under the column labeled “Background Count Rate (cpm).”

**Note: If the background of the survey site is expected to be significantly higher than typical background values, then the Project Manager will need to evaluate if this will affect the signal to noise and the HV Plateau may need to be completed while on-site.**

- 6.3.5 Adjust the HV to the next value listed on Attachment A.
- 6.3.6 Repeat steps 6.3.3 through 6.3.5 for each HV listed on Attachment A.
- 6.3.7 Place both the alpha and beta sources under the center area of the PSPC, ensuring the sources do not overlap each other. If a survey only has alpha or beta-emitting contaminants, then only an alpha or beta source needs to be used for the HV Plateau measurements.
- 6.3.8 Adjust the HV down to 900 V. After a few seconds to allow the voltage to stabilize, adjust the HV to 1000 V.
- 6.3.9 Acquire a one-minute gross measurement across the full length of the PSPC.
- 6.3.10 Record the value on Attachment A under the column labeled “Source + Background Count Rate (cpm).”
- 6.3.11 Adjust the HV to the next value listed on Attachment A.
- 6.3.12 Repeat steps 6.3.9 through 6.3.11 for each HV listed on Attachment A.
- 6.3.13 Remove the sources.
- 6.3.14 The Operator provides Attachment A to the Project Manager who will determine the OV. The OV is classically selected at a voltage at a

distance at or near 1/3 up the plateau. However, when conducting alpha surveys in high altitude areas, it may be prudent to select an alpha operating voltage at or near the knee of the alpha plateau to avoid beta cross-talk in the alpha channel.

6.3.15 Project Manager will determine alpha and/or beta OV, record the values, and sign Attachment A.

6.3.16 For alpha surveys, perform a 1 minute static count at the selected alpha OV using a 0.1  $\mu\text{Ci}$  SrY-90 point source or equivalent and ensure that the beta count rate does not exceed 1 cpm. Continue to lower the alpha OV to achieve less than 1 cpm beta. If this is not attainable, contact the Project Manager.

## **7.0 Required Records**

7.1 Attachment A – PSPC Plateau Determination Worksheet, or equivalent

## **8.0 Records Management**

8.1 The Operator is responsible for recording data on Attachment A. Once data collection is complete, the Operator will provide Attachment A to the Project Manager for review.

8.2 The Project Manager will review the data on Attachment A, determine and note the alpha and/or beta OV, and sign certifying the review. Attachment A should be located in a project file and archived after the project has been completed. It is recommended that any plots generated be included with Attachment A.

## **9.0 References**

9.1 SCM-OPS-01, *PSPC Purging*

9.2 SCM-SETUP-02, *Hardware Setup*

## ATTACHMENT A

### PSPC PLATEAU DETERMINATION WORKSHEET

SCM Serial \_\_\_\_\_

SCM Model: ☐ III ☐ IV

Number: \_\_\_\_\_

Operator: \_\_\_\_\_

Date: \_\_\_\_\_

PSPC ☐ Metal ☐ Trap ☐ Corner ☐ Plastic

PSPC Length \_\_\_\_\_

Type: \_\_\_\_\_

(cm): \_\_\_\_\_

Voltage (V)	Background Count Rate (cpm)	Source + Background Count Rate (cpm)	Voltage (V)	Background Count Rate (cpm)	Source + Background Count Rate (cpm)
1000			1875		
1100			1900		
1200			1925		
1300			1950		
1400			1975		
1500			1999		
1600					
1650					
1700					
1750					
1800					
1825					
1850					

Operating Voltages: Alpha \_\_\_\_\_ V

Beta \_\_\_\_\_ V

\_\_\_\_\_  
Project Manager Review

\_\_\_\_\_  
Date

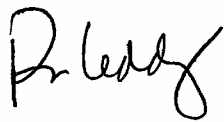
**Millennium Services, Inc.**

**Survey Procedure**

SCM-OPS-03, Rev. 1

PSPC Position Calibration

Effective Date: 06/11/08

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Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08
1	Incorporate clarifications identified during training	06/11/08

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## **1 PURPOSE**

This procedure details the requirements for performing a position calibration of a Position Sensitive Proportional Counter (PSPC) or PSPC array for use with the Surface Contamination Monitor (SCM). The design of the SCM acquisition system allows several PSPC configurations. To this end, the acquisition engine and software provide for adjustments to allow for the differences between the attributes of the different PSPC configurations. The most important of these adjustments is the position calibration. The position calibration allows the software to take the recorded information by the acquisition system and map it to a position on the PSPC.

## **2 SCOPE**

Any PSPC or PSPC array attached to SCM Model III or Model IV must have a completed position calibration. This calibration is performed per PSPC or PSPC array per SCM prior to first use and upon a failed confirmation. Confirmations are required to be performed daily.

## **3 RESPONSIBILITIES**

**NOTE: For small survey jobs, the following three roles may be filled by the same individual, provided the individual is trained to the appropriate level.**

### **3.1 Project Manager**

- 3.1.1 Reads and becomes familiar with this procedure.
- 3.1.2 Has successfully completed SCM Level I training for the SCM model being used.
- 3.1.3 Periodically reviews documentation (Attachment A) to ensure position calibration on a PSPC or PSPC array is performed according to this procedure.

### **3.2 Supervisor / Post Processor**

- 3.2.1 Reads and becomes familiar with this procedure.
- 3.2.2 Has successfully completed SCM Level I and Level II training for the SCM model being used.
- 3.2.3 Ensures position calibration on a PSPC or PSPC array is performed according to this procedure on a daily basis. Records review on Attachment A.

### **3.3 Operator**

- 3.3.1 Reads and becomes familiar with this procedure before performing calibration.
- 3.3.2 Has successfully completed SCM Level I training for the SCM model being used.

3.3.3 Performs all measurements according to this procedure. Records data on Attachment A.

#### 4 DEFINITIONS AND ACRONYMS

**Table 1: Definitions and Acronyms**

<b>Item</b>	<b>Description</b>
Binning Constants	The PSPC is divided into a number of segments called bins. The mapping of events to bins is controlled by the Binning Constants.
HV	High-voltage
LV	Low-voltage
P-10 Gas	90% argon / 10% methane gas mixture used in PSPC. Ultra high purity is recommended.
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity. A metal trapezoidal or plastic square cross-section PSPC is used for dynamic (rolling) surveys and a metal or plastic square cross-section PSPC is used for static (corner) surveys.
PSPC Array	The SCM can be configured using a single PSPC or a PSPC array. A PSPC array will consist of two or more PSPCs connected in series.
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.
SRA	Shonka Research Associates, Inc.
SRAPA	SRA Position Analyzer

## 5 MATERIALS, EQUIPMENT, AND SOFTWARE

**Table 2: Materials, Equipment, and Software**

Item	Specification
Powerbase	12 Volt DC 7500 mAh, Model DVL-9000Y
PSE4	SCM IV Electronics: Revision C: DSP Firmware Atmel Firmware External Power Supply
PSPC	Typical lengths include 1 and 2 meters. Custom lengths can be manufactured based on project requirements.
Radioactive Source	High count rate exempt quantity beta button source is recommended. A 0.1 $\mu$ Ci Sr/Y-90 source will produce a usable peak in a very short acquisition time.
SCM	Model III or IV

## 6 PROCEDURE

- 6.1 If using SCM Model III, continue to step 6.2. If using SCM Model IV, continue to step 6.3.
- 6.2 SCM Model III
  - 6.2.1 Set Binning Constants
    - 6.2.1.1 Record the SCM Serial Number, SCM Model, PSPC type, PSPC length, operator name, date, and PSPC Array on Attachment A.
    - 6.2.1.2 Select the option labeled <2. FM> from the *MS DOS 6.22 Startup Menu*. This option will automatically be selected after five seconds.
    - 6.2.1.3 At the *C:\FM5>* prompt, type either *rolling* or *corner* depending on the PSPC configuration and press the <Enter> key.
    - 6.2.1.4 The Survey parameters screen will be displayed. Press the <Enter> key twice. Enter a Survey Name. Press the <Enter> key. The screen that is now showing is the Operations screen.
    - 6.2.1.5 Press the <S> key to enter *Setup*.
    - 6.2.1.6 Press the <2> key to enter *Supervisor*. Enter the password if prompted.
    - 6.2.1.7 Press the <2> key to enter *Detector Width Specification*. If the required PSPC configuration is not listed, then the Project

Manager or designated SCM Level II trained person will need to modify the configuration files using SCM ECO002 (Reference 9.2) before continuing this procedure.

- 6.2.1.8 Press the appropriate key to select the PSPC configuration then press the <Enter> key.
- 6.2.1.9 If the PSPC Detector Width Reconfiguration screen appears, press the <Enter> key.
- 6.2.1.10 Press the <4> key to enter *Calibrations*.
- 6.2.1.11 Press the <2> key to enter *Detector Position*.
- 6.2.1.12 Press the <3> key to enter *Use Position Analyzer*. This option will run SRAPA. Ensure that the splash screen indicates version 2.01.
- 6.2.1.13 Place the radioactive source on the edge of the active area of the HV end of the PSPC. The edge of the active area of the source should align with the edge of the active area of the PSPC. Typically, the active area begins 10 cm from the outside edge of the trapezoidal PSPC and adjacent to the metal flange of the corner PSPC. When using a PSPC array, place the source at the left end of the primary (front) PSPC.
- 6.2.1.14 Press the <B> key to initiate setting of binning constants.
- 6.2.1.15 Press the <L> key to start an acquisition. This function positions the cursor near the left peak.
- 6.2.1.16 Use the left or right arrows as necessary to position the cursor at the peak centroid for a collimated alpha source or the full width to half maximum (FWHM) peak value.
- 6.2.1.17 When the cursor is set, place the radioactive source on the edge of the active area of the LV end of the PSPC. When using a PSPC array, place the source under the left edge of the secondary (rear) PSPC. Note that the software will automatically continue past this step after one minute and step 6.2.1.18 may be omitted.
- 6.2.1.18 Press the <L> key again to set the left channel. This action causes the cursor to move to the right peak.
- 6.2.2 Use the left or right arrows as necessary to position the cursor at the peak centroid.
- 6.2.3 Press the <R> key to set the right channel. Note that the software will automatically continue past this step after one minute.
- 6.2.4 Press the <ESC> key to complete setting of binning constants.
- 6.2.5 The computer will calculate the slope and intercept using the left and right channels identified. Record these values on Attachment A.
- 6.2.6 Set Detector End Points

- 6.2.6.1 If using a PSPC array, perform the following steps:
  - 6.2.6.1.1 Place the radioactive source at the right end of the active area of the primary (front) PSPC.
  - 6.2.6.1.2 Press the <A> key to begin a one-minute acquisition.
  - 6.2.6.1.3 Once a well defined peak has developed, move the cursor to the centroid of the peak using the arrow keys. Note that the cursor can be moved multiple channels at a time by holding down the <Shift> key while pressing the arrow key.
  - 6.2.6.1.4 Record the peak centroid channel number shown in SRAPA as End Point B on Attachment A. Press the <A> key to prematurely end the acquisition if one minute has not elapsed.
  - 6.2.6.1.5 Place the radioactive source at the right end of the active area of the secondary (rear) PSPC.
  - 6.2.6.1.6 Press the <A> key to begin a one-minute acquisition.
  - 6.2.6.1.7 Once a well defined peak has developed, move the cursor to the centroid of the peak using the arrow keys.
  - 6.2.6.1.8 Record the peak centroid channel number shown in SRAPA as End Point C on Attachment A. Press the <A> key to prematurely end the acquisition if one minute has not elapsed.
- 6.2.6.2 Press the <ESC> key to exit SRAPA.
- 6.2.6.3 Press the <1> key to enter *Set Detector End Points*.
- 6.2.6.4 Enter the end point for each PSPC. Press the appropriate letter key, e.g. <A>, enter the value noted below, and then press the <Enter> key.
  - 6.2.6.4.1 Set value A to 0. Note this value as End Point A on Attachment A.
  - 6.2.6.4.2 For a single PSPC, set value B to 2047. Record this value as End Point B on Attachment A. Record N/A for End Points C and D on Attachment A. For a PSPC array, set value B to the peak centroid recorded for step 6.2.6.1.4.
  - 6.2.6.4.3 For a PSPC array, set value C to the peak centroid recorded for step 6.2.6.1.8.
  - 6.2.6.4.4 For a PSPC array, set value D to 2047. Record this value as End Point D on Attachment A.
- 6.2.6.5 Press the <Enter> key to *Accept End Points*.
- 6.2.6.6 Press the <ESC> key twice to *Return to Previous* menus.

- 6.2.6.7 Press the <5> key to enter *Maintenance*.
- 6.2.6.8 Press the <4> key to enter *DOS Functions*.
- 6.2.6.9 Press the <1> key to *Exit to DOS*.
- 6.2.6.10 Press <CTRL> <ALT> <DEL> to reboot the computer. Note that the computer must be rebooted before collecting survey data anytime SRAPA has been used.

### 6.3 SCM Model IV

#### 6.3.1 Set Binning Constants

- 6.3.1.1 Record the SCM Serial Number, SCM Model, PSPC type, PSPC length, operator name, date, and PSPC Array on Attachment A.
- 6.3.1.2 Log into Windows.
- 6.3.1.3 Open (run) the *PSPC Server* then open (run) the *SCM Interface*.
- 6.3.1.4 Log into the SCM Interface to open *Survey Information*.
- 6.3.1.5 Open the *Survey* tab and select *New Survey*. “*Unnamed*” will appear in the *Survey Name* field. Performing this step will prevent alteration of binning constants that would be applied to subsequent strips on an existing survey.
- 6.3.1.6 Open the *Advanced* tab and verify the values for the *Discriminator* and *Coincidence Window* agree with the values in the following table. If the values do not agree, notify the Project Manager before proceeding.

Parameter	Min	Max
Discriminator Left (mV)	100	12,000
Discriminator Right (mV)	100	12,000
Discriminator Total	200	24,000
Coincidence Window	2	

- 6.3.1.7 Open the *Detector* folder and select the PSPC configuration from the *Detector* list and select *OK*. The *SCM Interface* screen will appear.

**Note: If the required PSPC configuration is not listed, then the Project Manager or designated SCM Level II trained person will need to modify the PSPC database using the *Detector Array Manager*.**

#### 6.3.2 Open the *Detector* folder and select *Position Analyzer*.

- 6.3.2.1 From the *Position Analyzer* screen select *Set Binning Constants*.

- 6.3.2.2 Align the radioactive source on the edge of the active area of the HV end of the PSPC (left side looking from operator's position). The edge of the active area of the source should align with the edge of the active area of the PSPC.

**Note: A PSPC recount array is not supported with the current SCM Model IV design.**

- 6.3.2.3 Select the *Left Channel* button to begin acquiring data.
- 6.3.2.4 After the one minute count is complete, align the screen cursor with the left edge of the source peak and press the *Left Channel* button again to set the left channel.
- 6.3.2.5 Align the radioactive source on the edge of the active area of the other end of the PSPC (right side looking from operator's position).
- 6.3.2.6 Select the *Right Channel* button to begin acquiring data.
- 6.3.2.7 After the one minute count is complete, align the screen cursor with the right edge of the source peak and press the *Right Channel* button again to set the right channel.
- 6.3.2.8 Select *Quit Set Binning Constants*.
- 6.3.2.9 Record the binning constants (slope and intercept values) on Attachment A.
- 6.3.2.10 Select *Quit/Esc* to exit *Position Analyzer* and return to *Survey Information*.
- 6.3.2.11 Open the *Detector* folder and verify the binning constants established for the left and right channels. Select *OK* to save the binning constants.

#### 6.4 Position Confirmation

- 6.4.1 If not already in the Position Analyzer mode, perform steps 6.3.1.2, 6.3.1.3, 6.3.1.4, and 6.3.1.8, as appropriate to access the mode.
- 6.4.2 Place a large area radioactive source at the HV end of the intended active area of the detector array.
- 6.4.3 Press the *Acquire* button and start a one-minute acquisition.
- 6.4.4 Verify that the left side of the peak occurs at the left edge of the display screen.
- 6.4.5 If the peak does not occur at the left edge of the display, perform the necessary steps for either SCM III or IV to set the binning constants.
- 6.4.6 Repeat steps 6.4.12 and 6.4.53 for the other end of the intended active area of the array.
- 6.4.7 Verify that the right side of the peak occurs at the right edge of the display screen.
- 6.4.8 If the peak does not occur at the right edge of the display, perform the necessary steps for either SCM III or IV to set the binning constants.

### 7 REQUIRED RECORDS

- 7.1 Attachment A– PSPC Array Position Calibration Record, or equivalent

### 8 RECORDS MANAGEMENT

- 8.1 The Operator is responsible for recording data on Attachment A. Once data collection is complete, the Operator will provide Attachment A to the Supervisor.
- 8.2 The Supervisor will review the data on Attachment A and initial and date indicating the review. The Supervisor will provide Attachment A to the Project Manager and/or file in a location specified by the Project Manager.
- 8.3 The Project Manager is responsible for Attachment A once the Supervisor has reviewed the data. Attachment A should be located in a project file and archived after the project has been completed.

### 9 REFERENCES

- 9.1 SCM-OPS-02, PSPC Plateau Determination
- 9.2 SCM ECO002 Revision 1, May 5/15/1999.

## ATTACHMENT A

### PSPC ARRAY POSITION CALIBRATION RECORD

SCM Serial Number: \_\_\_\_\_ SCM Model: ☐ III ☐ IV

Operator: \_\_\_\_\_ Date: \_\_\_\_\_

PSPC Type: ☐ Metal ☐ Trap ☐ Corner ☐ Plastic PSPC Length (cm): \_\_\_\_\_

PSPC / PSPC Array: ☐ Single PSPC ☐ Multiple PSPC

Position Calibration Performed ☐ Satisfactory

Binning Constants: Slope \_\_\_\_\_ Intercept \_\_\_\_\_

Position Confirmation Performed ☐ Satisfactory

Operator Initials: \_\_\_\_\_

\_\_\_\_\_  
Project Manager Review

\_\_\_\_\_  
Date

**Millennium Services, Inc.**

**Survey Procedure**

SCM-OPS-04, Rev. 0

Encoder Calibration

Effective Date: 01/17/08

A handwritten signature in black ink, appearing to read "Priddy", is written over the signature line.

Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08

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## 1 PURPOSE

This procedure details the requirements for the calibration and confirmation of the incremental encoder included on the Surface Contamination Monitor (SCM) Model III or IV.

## 2 SCOPE

Any SCM used to conduct a dynamic survey, using a precision wheel encoder, must have completed a valid encoder calibration to ensure proper scan speed, accuracy of position correlated data and locations of elevated activity.

## 3 RESPONSIBILITIES

### 3.1 Project Manager

3.1.1 Reads and becomes familiar with this procedure.

3.1.2 Has successfully completed SCM Level I training for the SCM model being used.

3.1.3 Reviews documentation (Attachment A, Attachment B, or Attachment C) to ensure efficiency measurement for a PSPC is performed according to this procedure.

### 3.2 Operator(s)

3.2.1 Reads and becomes familiar with this procedure before performing calibration.

3.2.2 Has successfully completed SCM Level I training for the SCM model being used.

3.2.3 Performs all measurements according to this procedure. Records data on Attachment A, Attachment B, or Attachment C.

## 4 DEFINITIONS AND ACRONYMS

**Table 1: Definitions and Acronyms**

Item	Description
in/sec	inches per second
m	meter
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.
SRA	Shonka Research Associates, Inc.

## 5 MATERIALS, EQUIPMENT, AND SOFTWARE

**Table 2: Materials, Equipment, and Software**

Item	Specification
<b>General</b>	
SCM	Model III or IV.
SCM Process Software	Version 2.0 or later
Tape	Tape must be suitable for securing tape measure to floor surface, e.g. electrical tape.
Tape Measure	10 m or longer

## 6 PROCEDURE

- 6.1 Ensure the SCM hardware is setup per Reference 10.1.
- 6.2 If using SCM Model III, continue to step 6.3. If using SCM Model IV, continue to step 6.3.3
- 6.3 SCM Model III
  - 6.3.1 For an encoder that was out of service, had a questionable calibration, or requires a new calibration, continue to step 6.3.2. For an encoder in service, a confirmation measurement must be performed to compare to the previous calibration; continue to step 6.3.3.
  - 6.3.2 Encoder Calibration
    - 6.3.2.1 Record the SCM, computer, and electronics serial numbers on Attachment A.
    - 6.3.2.2 Record the actual distance in meters on Attachment A.
    - 6.3.2.3 Record the target distance in inches on Attachment A using the equation below.
$$TargetDistance_{inch} = ActualDistance_{meter} \times 40_{inch/meter}$$
    - 6.3.2.4 Secure the tape measure to the floor using tape at the 0 m mark.
    - 6.3.2.5 Extend the tape measure and secure it to the floor at a distance of 10 m or more with a second piece of tape. The Project Manager may approve an alternate distance.
    - 6.3.2.6 If the target survey speed is less than 2 in/sec, set the motor controller to 2 in/sec, else set the motor controller to the target survey speed.
    - 6.3.2.7 Enter a new survey name. The Project Manager will provide the survey naming convention.

- 6.3.2.8 Position the SCM at either piece of tape.
- 6.3.2.9 Roll the cart forward and line up with the opposite piece of electrical tape.

**Note: The cart must be kept traveling in a straight line. The operator may use the tape measure and a fixed point on the frame to guide the cart. In addition, take care when aligning the cart to the tape to avoid parallax error.**

- 6.3.2.10 Initiate the measurement.
- 6.3.2.11 Complete the measurement after moving 10 m, or the Project Manager approved distance, as measured on the tape measure.
- 6.3.2.12 Record the reported strip length in inches in the Strip Lengths table on Attachment A.
- 6.3.2.13 Repeat steps 6.3.2.8 through 6.3.2.12 two additional times.
- 6.3.2.14 Calculate the mean (old distance) of the three measurements and record the value on Attachment A.
- 6.3.2.15 Calculate the percent deviation from the mean for each of the three measurements, using the equation below, and record the values on Attachment A.

$$Deviation_{\%} = \left| \frac{Mean_{inch} - Measurement_{inch}}{Mean_{inch}} \right|$$

- 6.3.2.16 Record the old encoder calibration constant (found on line 7 of the FM.DEF file) on Attachment A.
- 6.3.2.17 Calculate the new encoder constant using the equation below and record the value on Attachment A.

$$Constant_{New} = \frac{Constant_{Old} * Distance_{Old}}{TargetDistance}$$

- 6.3.2.18 Update Line 7 of FM.DEF with the new encoder constant.
- 6.3.2.19 Evaluate the data per the criteria provided in step 8.1.
- 6.3.2.20 Perform encoder confirmation starting with step 6.3.3.
- 6.3.2.21 Provide Attachment A and Attachment B to the Project Manager for review.

### 6.3.3 Confirmation Measurement

- 6.3.3.1 Record the SCM, computer, and electronics serial numbers on Attachment B.

- 6.3.3.2 Record the actual distance in meters on Attachment B.
- 6.3.3.3 Record the target distance in inches on Attachment B using the equation below.  

$$TargetDistance_{inch} = ActualDistance_{meter} \times 40_{inch/meter}$$
- 6.3.3.4 Secure the tape measure to the floor using tape at the 0 m mark.
- 6.3.3.5 Extend the tape measure and secure it to the floor at a distance of 10 m or more with a second piece of tape. The Project Manager may approve an alternate distance.
- 6.3.3.6 If the target survey speed is less than 2 in/sec, set the motor controller to 2 in/sec, else set the motor controller to the target survey speed.
- 6.3.3.7 Enter a new survey name. The Project Manager will provide the survey naming convention.
- 6.3.3.8 Position the SCM at either piece of tape.
- 6.3.3.9 Roll the cart forward and line up with the opposite piece of electrical tape.

NOTE: The cart must be kept traveling in a straight line. The operator may use the tape measure and a fixed point on the frame to guide the cart. In addition, take care when aligning the cart to the tape to avoid parallax error.

- 6.3.3.10 Initiate the measurement.
- 6.3.3.11 Complete the measurement after moving 10 m, or the Project Manager approved distance, as measured on the tape measure.
- 6.3.3.12 Record the reported strip length in inches in the Strip Lengths table on Attachment B.
- 6.3.3.13 Repeat steps 6.3.3.8 through 6.3.3.12 two additional times.
- 6.3.3.14 Calculate the mean of the three measurements and record the value on Attachment B.
- 6.3.3.15 Calculate the percent deviation from the mean for each of the three measurements, using the equation below, and record the values on Attachment B.

$$Deviation_{\%} = \left| \frac{Mean_{inch} - Measurement_{inch}}{Mean_{inch}} \right|$$

- 6.3.3.16 Calculate the mean deviation from the target distance, using the equation below, and record the value on Attachment B.

$$Deviation_{\%} = \left| \frac{Target_{inch} - Mean_{inch}}{Target_{inch}} \right|$$

6.3.3.17 Evaluate the data per the criteria provided in step 8.2.

6.3.3.18 Provide Attachment B to the Project Manager for review.

## 6.4 SCM Model IV

### 6.4.1 Encoder Calibration

6.4.1.1 An encoder calibration must be performed for the SCM IV prior to use, after an encoder or wheel replacement, or if a more limiting site requirement prescribes it, or upon a failed confirmation.

**Note: As connecting multiple encoders to the SCM Model IV electronics is simple; care must be taken to ensure the correct encoder constant is used. It is recommended that each encoder plate be assigned to a specific SCM.**

6.4.1.2 If necessary, begin a new log and note the SCM serial number on Attachment C.

6.4.1.3 Record Operator initials and date performed on Attachment C.

6.4.1.4 Secure the tape measure to the floor using tape at the 0 m mark.

6.4.1.5 Extend the tape measure and secure it to the floor at a distance of 10 m or more with a second piece of tape. The Project Manager may approve an alternate distance.

6.4.1.6 From the *Equipment* tab of the *Survey Information* form of the SCM IV software, click the *Calibrate* button. Follow the software wizard that loads.

6.4.1.7 After the wizard has completed, record the new encoder constant on Attachment C.

**Note: The *Equipment* tab provides for input from two encoders. The encoder constant is a single value and is not saved per selected encoder.**

### 6.4.2 Confirmation Measurement

6.4.2.1 Follow the steps as outlined in 6.3.3

6.4.3 Provide Attachment C to the Project Manager, or designee, for review.

## 7 REQUIRED RECORDS

7.1 Attachment A – Encoder Calibration Worksheet, SCM Model III, or equivalent

- 7.2 Attachment B – Encoder Confirmation Worksheet, SCM Model III, or equivalent
- 7.3 Attachment C – Encoder Calibration Log, SCM Model IV, or equivalent

## **8 ACCEPTANCE CRITERIA**

### **8.1 Encoder Calibration**

The percent deviation from the mean for each of the three measurements is within 2%.

### **8.2 Encoder Confirmation**

8.2.1.1 The percent deviation from the mean for each of the three measurements is within 2%.

8.2.1.2 The mean of the three measurements are within 1% of the target distance.

## **9 RECORDS MANAGEMENT**

- 9.1 The Operator is responsible for recording data on Attachment A, Attachment B, or Attachment C as appropriate. Once data collection is complete, the Operator will provide Attachment A, Attachment B, or Attachment C and electronic records, as necessary, to the Project Manager.
- 9.2 The Project Manager will review the data on Attachment A, Attachment B, or Attachment C and sign certifying the review. Attachment A, Attachment B, or Attachment C should be located in a project file and archived after the project has been completed.

## **10 REFERENCES**

- 10.1 SCM SETUP-02, *Hardware Setup*

# ATTACHMENT A

## ENCODER CALIBRATION WORKSHEET

### SCM MODEL III

<b>SCM III S/N:</b>		<b>Computer S/N:</b>	
<b>Electronics S/N:</b>		<b>Actual Distance (m):</b>	
<b>Target Speed (in./sec):</b>		<b>Target Distance (in.):*</b>	

\*  $TargetDistance_{inch} = ActualDistance_{meter} \times 40_{inch/meter}$

NOTE: Perform this calibration at the intended survey speed, unless the survey speed is less than 2 in/sec. If survey speed is less than 2 in/sec then perform confirmation at 2 in/sec.

#### Strip Lengths

Measurement	Distance (in.)	Deviation from Mean (%)**
1		
2		
3		
Mean (Distance <sub>Old</sub> )		

\*\*  $Deviation_{\%} = \left| \frac{Mean_{inch} - Measurement_{inch}}{Mean_{inch}} \right|$

**Constant<sub>Old</sub>** (from Line 7 of FM.DEF): \_\_\_\_\_ (pulse/in.)

**Constant<sub>New</sub>\*\*\*:** \_\_\_\_\_ (pulse/in.)      \*\*\*  $Constant_{New} = \frac{Constant_{Old} * Distance_{Old}}{TargetDistance}$

Initials _____	Deviation from Mean for Each Measurement Within 3% of the Mean		
Initials _____	Update Line 7 of FM.DEF with Constant <sub>New</sub>		
Initials _____	Perform Encoder Confirmation		
Initials _____	Passed		
Initials _____	Failed	Reason:	

#### Data Review

Data Review	Name	Date	Signature
Operator			
Project Manager			

## ATTACHMENT B

### ENCODER CONFIRMATION WORKSHEET

<b>SCM S/N:</b>		<b>Computer S/N:</b>	
<b>Electronics S/N:</b>		<b>Actual Distance (m):</b>	
<b>Target Speed (in./sec):</b>		<b>Target Distance (in.):*</b>	

\*  $TargetDistance_{inch} = ActualDistance_{meter} \times 40_{inch/meter}$

NOTE: Perform this confirmation at the intended survey speed, unless the survey speed is less than 2 in/sec. If survey speed is less than 2 in/sec then perform confirmation at 2 in/sec.

#### Strip Lengths

Measurement	Distance (in.)	Deviation from Mean (%)**
1		
2		
3		
Mean		

**Mean Deviation from Target Distance\*\*\*: \_\_\_\_\_ %**

\*\*  $Deviation_{\%} = \left| \frac{Mean_{inch} - Measurement_{inch}}{Mean_{inch}} \right|$

\*\*\*  $Deviation_{\%} = \left| \frac{Target_{inch} - Mean_{inch}}{Target_{inch}} \right|$

Initials _____	Deviation from Mean for Each Measurement Within 2% of the Mean		
Initials _____	Mean Deviation from Target Distance Less Than 1%		
Initials _____	Passed		
Initials _____	Failed	Reason:	

#### Data Review

Data Review	Name	Date	Signature
Operator			
Project Manager			

**ATTACHMENT C**  
**ENCODER CALIBRATION LOG**  
**SCM MODEL IV**

SCM Serial Number: \_\_\_\_\_

Operator Initials & Date	Encoder Constant (ticks/2.5 cm)	Reviewer Initials & Date	Operator Initials & Date	Encoder Constant (ticks/2.5 cm)	Reviewer Initials & Date

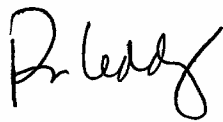
**Millennium Services, Inc.**

**Survey Procedure**

SCM-OPS-05, Rev. 0

PSPC Efficiency Calibration

Effective Date: 01/17/08

A handwritten signature in black ink, appearing to read "Priddy", is written over the signature line.

Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08

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## **1 PURPOSE**

This procedure details the requirements for the efficiency calibration of Position Sensitive Proportional Counters (PSPC) for use with the Surface Contamination Monitor (SCM) Models III and IV.

## **2 SCOPE**

The SCM must have an efficiency calibration performed for each PSPC type for each contaminant, surrogate, or contaminate mixture prior to use. The efficiency calibration will be performed prior to use or annually during continuous use unless a more limiting schedule is required by the Project Manager. Efficiency calibrations are recommended to be performed on site. The efficiency calibration includes measurements, data processing, and calculations.

This procedure does not detail actions required to perform the calibration measurements on the respective SCM model being calibrated. Operation of software for data processing is also not detailed in this procedure. The specific training requirements noted below are relied upon to implement this procedure.

## **3 RESPONSIBILITIES**

### **3.1 Project Manager**

- 3.1.1 Reads and becomes familiar with this procedure.
- 3.1.2 Has successfully completed SCM Level I training for the SCM model being calibrated.
- 3.1.3 Reviews documentation (Attachment A or Attachment B) to ensure efficiency calibration for a PSPC is performed according to this procedure.

### **3.2 Data Processor**

- 3.2.1 Reads and becomes familiar with this procedure before performing data processing and efficiency calculations.
- 3.2.2 Has successfully completed SIMS Level I training, if performing the calibration for SCM III.
- 3.2.3 Reviews documentation (Attachment A or Attachment B) to ensure efficiency measurement for a PSPC is performed according to this procedure.
- 3.2.4 Performs efficiency calculation using data provided by operator(s), and records results on Attachment A or Attachment B.
- 3.2.5 Per approval by the Project Manager, the Data Processor may also serve as the Operator.

### **3.3 Operator(s)**

- 3.3.1 Reads and becomes familiar with this procedure before performing calibration measurements.
- 3.3.2 Has successfully completed SCM Level I training for the SCM model being calibrated.
- 3.3.3 Performs all measurements according to this procedure. Records data on Attachment A or Attachment B.

#### 4 DEFINITIONS AND ACRONYMS

**Table 1: Definitions and Acronyms**

Item	Description
HV	High-voltage
LV	Low-voltage
LLD	Lower level discriminator
NIST	National Institute of Standards and Technology
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity.
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.
SIMS	Survey Information Management System – SIMS is flexible and comprehensive interfacing software for the SRA SCM. SIMS processes the SCM instrument data with a sophisticated data parser, integrated spreadsheet, and powerful special functions such as spatial data filters. SIMS provides the most flexible reporting system available for printing survey records or complete stand-alone survey reports. SIMS contains all the tools needed to meaningfully communicate between the SCM and the data analysis team. The main programs of the SIMS software are Stitcher, Visuspect, and Stracker.
SRA	Shonka Research Associates, Inc.

## 5 MATERIALS, EQUIPMENT, AND SOFTWARE

**Table 2: Materials, Equipment, and Software**

Item	Specification
Alpha and Beta Radioactive Sources	High count rate alpha and beta sources with 100 cm <sup>2</sup> active areas are recommended. A total count rate in excess of 10,000 counts per minute is recommended. NIST-traceable sources are recommended.
PSPC	Typical lengths include 1 and 2 meters and can be constructed using metal or plastic. Custom lengths can be manufactured based on project requirements.
SCM	Model III or IV.
SIMS	Stitcher v5.1n or higher; Visuspect v5.3l or higher; Stracker v2.0 or higher
Small Flat-Head Screwdriver	Jeweler's-sized screwdriver is required for adjusting SCM Model III electronics.

## 6 PROCEDURE

### 6.1 Efficiency Measurement Performed by the Operator

- 6.1.1 Ensure the PSPC is purged per Reference 9.1. Note that step 6.1.2 can be completed while the PSPC is purging.
- 6.1.2 Ensure the SCM hardware is setup per Reference 9.2.
- 6.1.3 Ensure the SCM high voltage is set to the operating voltage(s) determined per Reference 9.3.
- 6.1.4 Ensure that the PSPC has been position calibrated per Reference 9.4.
- 6.1.5 If performing measurements utilizing the wheel encoder, ensure an encoder calibration and/or confirmation has been performed per Reference 9.5.
- 6.1.6 Review with the Project Manager, or designee, the PSPC calibration strategy for this calibration measurement to assist with selecting proper equipment and calibration source(s). Continue once all supplies have been procured.
- 6.1.7 Attachment A of this procedure will be used with SCM Model III and Attachment B will be used with SCM Model IV.
- 6.1.8 If using SCM Model III, continue to step 6.1.9, otherwise, if using SCM Model IV, continue to step 6.1.10.
- 6.1.9 SCM Model III
  - 6.1.9.1 Record the SCM III, computer, electronics, and HV and LV pre-amplifier serial numbers in the Equipment Configuration table of Attachment A.

- 6.1.9.2 Record the A and B LLD settings, operating voltage, PSPC type (e.g. T180), and Mylar thickness (nominally 0.85 mg/cm<sup>2</sup>) on Attachment A.
  - 6.1.9.3 Record the speed, in inches per second, for a dynamic calibration measurement or the count time, in milliseconds, followed by the simuspeed in parenthesis, e.g. 4000 (1.0) for a static calibration measurement on Attachment A.
  - 6.1.9.4 If a recount PSPC is utilized for this calibration measurement, circle the appropriate method on Attachment A. Otherwise circle NA.
  - 6.1.9.5 For each calibration source selected, complete the Calibration Source(s) Information table of Attachment A.
  - 6.1.9.6 The survey name nomenclature may be defined on a project by project basis. A recommended default name is to use a leading character of P, type the SCM serial number, enter the month and day as MMDD, enter the last digit of the year, then enter a sequential letter starting with A as the last character. For example, the first efficiency measurement of February 1, 2006 on SCM #1 would be P102016A.
  - 6.1.9.7 Continue to step 6.1.11.
- 6.1.10 SCM Model IV
- 6.1.10.1 Record the PSE4 serial number and software suite version number in the Equipment Configuration table of Attachment B.
  - 6.1.10.2 Record the minimum and maximum settings for both the left, right, and total discriminators on Attachment B.
  - 6.1.10.3 Record the operating voltage, PSPC type (e.g. P90), Mylar thickness (nominally 0.85 mg/cm<sup>2</sup>), and Coincidence Window setting on Attachment B.
  - 6.1.10.4 Record the target speed, in centimeters per second, for a dynamic calibration measurement or the static constant, in milliseconds, for a static calibration measurement on Attachment B.
  - 6.1.10.5 If a recount PSPC is utilized for this calibration measurement, circle the appropriate method on Attachment B. Otherwise circle NA.
  - 6.1.10.6 For each calibration source selected, complete the Calibration Source(s) Information table of Attachment B.
  - 6.1.10.7 The Project Manager will determine the survey naming convention.
- 6.1.11 Calculate and record the decay corrected  $q_{2\pi}$  emission rate, in particles/sec/100 cm<sup>2</sup>, for each source listed in the Calibration Source(s)

Information table of Attachment A or Attachment B. Use the following equation to perform the calculation:

$$\text{Decay Corrected } q_{2\pi} = \left[ q_{2\pi} \cdot e^{\frac{-(\ln 2)t}{T_{1/2}}} \right] \cdot \left[ \frac{100}{A} \right], \text{ where}$$

t = time, in years, between assay date and calibration date;  $T_{1/2}$  = half life, in years of the calibration source; A = active area of the calibration source (cm<sup>2</sup>)

**Note: If the area of the calibration source is larger than the width of the PSPC (e.g., 12 cm), then use the 100/A factor, otherwise ignore the geometry correction.**

- 6.1.12 For each calibration source noted on the Calibration Source(s) Information table of Attachment A or Attachment B, perform a minimum of ten (10) to a maximum of thirty (30) randomly selected measurements of the calibration source in the same method as the surveys will be performed in the field, i.e. same geometry and survey speed or static count time.
- 6.1.13 Provide electronic data and Operator(s) signed Attachment A or Attachment B to the Data Processor.

## 6.2 Efficiency Calculation Performed by the Data Processor

- 6.2.1 If using SCM III data, download the data into the SIMS software. If using SCM IV, use the PBC/Cal reporting function. Process the electronic data to determine the maximum 100 cm<sup>2</sup> data point for each of the strips per source listed in the Calibration Source(s) Information table of Attachment A or Attachment B.
- 6.2.2 Calculate the Average of the maximum 100 cm<sup>2</sup> measurements (step 6.2.1) for each source. Record the value(s) in the Efficiency Calculation table of Attachment A or Attachment B.
- 6.2.3 Calculate the Instrument Efficiency ( $\epsilon_i$ ) by dividing the Average recorded in step 6.2.2 by the Decay Corrected  $q_{2\pi}$  Emission rate recorded in the Calibration Source(s) Information table (step 6.1.11) for each source. Record the Instrument Efficiency ( $\epsilon_i$ ) value(s) in the Efficiency Calculation table of Attachment A or Attachment B.
- 6.2.4 Record the Surface Efficiency ( $\epsilon_s$ ) for each source in the Efficiency Calculation table provided by the Project Manager.

**Note: The Project Manager will determine what guidance to be used in assuming or measuring the surface efficiency. The surface efficiency may not necessarily be determined based on the emission energy of the calibration source.**

- 6.2.5 Record the Fraction (f) for each source in the Efficiency Calculation table provided by the Project Manager.

- 6.2.6 Calculate the Subtotal Efficiency ( $\epsilon_t$ ) by multiplying the Instrument Efficiency ( $\epsilon_i$ ), the Surface Efficiency ( $\epsilon_s$ ), and the Fraction ( $f$ ) together for each source. Record the Subtotal Efficiency ( $\epsilon_t$ ) value(s) in the Efficiency Calculation table of Attachment A or Attachment B.
- 6.2.7 Calculate the Total Efficiency ( $\epsilon_T$ ) by summing the column of Subtotal Efficiency ( $\epsilon_t$ ) values. Record the Total Efficiency ( $\epsilon_T$ ) value in the Efficiency Calculation table of Attachment A or Attachment B.
- 6.2.8 Provide Data Processor signed Attachment A or Attachment B to the Project Manager.

## **7 REQUIRED RECORDS**

- 7.1 Attachment A – PSPC Efficiency Worksheet – SCM Model III, or equivalent
- 7.2 Attachment B – PSPC Efficiency Worksheet – SCM Model IV, or equivalent

## **8 RECORDS MANAGEMENT**

- 8.1 The Operator is responsible for recording data on Attachment A or Attachment B as appropriate. Once data collection is complete, the Operator will provide Attachment A or Attachment B and electronic records, as necessary, to the Data Processor.
- 8.2 The Data Processor is responsible for analyzing the data provided by the Operator and completing Attachment A or Attachment B. Once the efficiency calculation is complete, the Data Processor will provide Attachment A or Attachment B to the Project Manager.
- 8.3 The Project Manager will review the data on Attachment A or Attachment B and sign certifying the review. Attachment A or Attachment B should be located in a project file and archived after the project has been completed.

## **9 REFERENCES**

- 9.1 SCM OPS-01, *PSPC Purging*
- 9.2 SCM SETUP-02, *SCM Hardware Setup*
- 9.3 SCM OPS-02, *PSPC Plateau Determination*
- 9.4 SCM OPS-03, *PSPC Position Calibration*
- 9.5 SCM OPS-04, *Encoder Calibration*

# ATTACHMENT A

## PSPC EFFICIENCY WORKSHEET – SCM MODEL III

### Equipment Configuration

<b>SCM III S/N:</b>		<b>Computer S/N:</b>	
<b>Electronics S/N:</b>		<b>HV Pre-amp S/N:</b>	
<b>LV Pre-amp S/N:</b>		<b>A/B LLD Settings (mV):</b>	/
<b>Operating Voltage (V):</b>		<b>PSPC Type (e.g. T180):</b>	
<b>Mylar Thickness (mg/cm<sup>2</sup>):</b>		<b>Speed (in./sec) or Count Time (msec):</b>	
<b>Recount Method (circle):</b>	Average / Gamma Subtraction / NA		

### Calibration Source(s) Information

	Serial Number	Isotope	Emission Type	Half Life (years)	Assay Date	q <sub>2π</sub> Emission (particles/sec)	Active Area (cm <sup>2</sup> )	Decay Corrected q <sub>2π</sub> Emission*
1								
2								
3								
4								
5								

\* To calculate the decay corrected q<sub>2π</sub> emission rate in particle/sec/100 cm<sup>2</sup>:

$$\text{Decay Corrected } q_{2\pi} = \left[ q_{2\pi} \cdot e^{\frac{-(\ln 2)t}{T_{1/2}}} \right] \cdot \left[ \frac{100}{A} \right], \text{ where}$$

t = time, in years, between assay date and calibration date

T<sub>1/2</sub> = half life, in years

A = active area (cm<sup>2</sup>)

NOTE: The 100/A factor is only used when the area of the calibration source is larger than the width of the PSPC.

### Data File Information

	Filename	Number of Strips
1		
2		
3		
4		
5		

**ATTACHMENT A (cont'd)**

**Efficiency Calculation**

	<b>Average (cpm/100 cm<sup>2</sup>)</b>	<b>Instrument Efficiency (<math>\epsilon_i</math>)</b>	<b>Surface Efficiency (<math>\epsilon_s</math>)</b>	<b>Fraction (f)</b>	<b>Subtotal Efficiency (<math>\epsilon_t</math>)</b>
1					
2					
3					
4					
5					
<b>Total Efficiency (<math>\epsilon_T</math>):</b>					

**Data Review**

<b>Data Review</b>	<b>Name</b>	<b>Date</b>	<b>Signature</b>
Operator			
Operator			
Data Processor			
Project Manager			

# ATTACHMENT B

## PSPC EFFICIENCY WORKSHEET – SCM MODEL IV

### Equipment Configuration

<b>PSE4 S/N:</b>		<b>Software Suite Version:</b>	
<b>Discrim. Left Min (mV):</b>		<b>Discrim. Left Max (mV):</b>	
<b>Discrim. Right Min (mV):</b>		<b>Discrim. Right Max (mV):</b>	
<b>Discrim. Total Min (mV):</b>		<b>Discrim. Total Max (mV):</b>	
<b>Operating Voltage (V):</b>		<b>PSPC Type (e.g. P90):</b>	
<b>Mylar Thickness (mg/cm<sup>2</sup>):</b>		<b>Target Speed (cm/sec) or Static Constant (msec):</b>	
<b>Coincidence Window:</b>			
<b>Recount Method (circle):</b>	Average / Gamma Subtraction / NA		

### Calibration Source(s) Information

	Serial Number	Isotope	Emission Type	Half Life (years)	Assay Date	q <sub>2π</sub> Emission (particles/sec)	Active Area (cm <sup>2</sup> )	Decay Corrected q <sub>2π</sub> Emission*
1								
2								
3								
4								
5								

\* To calculate the decay corrected q<sub>2π</sub> emission rate in particle/sec/100 cm<sup>2</sup>:

$$\text{Decay Corrected } q_{2\pi} = \left[ q_{2\pi} \cdot e^{\frac{-(\ln 2)t}{T_{1/2}}} \right] \cdot \left[ \frac{100}{A} \right], \text{ where}$$

t = time, in years, between assay date and calibration date

T<sub>1/2</sub> = half life, in years

A = active area (cm<sup>2</sup>)

NOTE: The 100/A factor is only used when the area of the calibration source is larger than the width of the PSPC.

### Survey Information

	Survey Name	Number of Strips
1		
2		
3		
4		
5		

**ATTACHMENT B (cont'd)**

**Efficiency Calculation**

	<b>Average (cpm/100 cm<sup>2</sup>)</b>	<b>Instrument Efficiency (<math>\epsilon_i</math>)</b>	<b>Surface Efficiency (<math>\epsilon_s</math>)</b>	<b>Fraction (f)</b>	<b>Subtotal Efficiency (<math>\epsilon_t</math>)</b>
1					
2					
3					
4					
5					
<b>Total Efficiency (<math>\epsilon_T</math>):</b>					

**Data Review**

<b>Data Review</b>	<b>Name</b>	<b>Date</b>	<b>Signature</b>
Operator			
Operator			
Data Processor			
Project Manager			


**Millennium Services, Inc.**

**Survey Procedure**

SCM-OPS-06, Rev. 1

PSPC Quality Assurance

Effective Date: 06/11/08

A handwritten signature in black ink, appearing to read "R. Leary", is written over the horizontal line of the "Approved by:" field.

Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08
1	Incorporate clarifications identified during training	06/11/08

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## 1 PURPOSE

This procedure details the requirements for baseline source response checks (SRC), daily SRCs, and Performance Based Checks (PBC) of Position Sensitive Proportional Counters (PSPC) for use with the Surface Contamination Monitor (SCM) Models III and IV.

## 2 SCOPE

Normal operation of the SCM with a PSPC requires daily SRC measurements to assure that the PSPC is performing within acceptable limits per regulatory requirements (ANSI N323A). To establish system performance during the survey, PBC measurements are frequently performed throughout the course of the survey.

## 3 RESPONSIBILITIES

**NOTE: For small survey jobs, the following three roles may be filled by the same individual, provided the individual is trained to the appropriate level.**

### 3.1 Project Manager

- 3.1.1 Reads and becomes familiar with this procedure.
- 3.1.2 Has successfully completed SCM Level I training for the SCM model being used.
- 3.1.3 Reviews documentation (Attachment A or Attachment B) to ensure quality assurance measurements for a PSPC are performed according to this procedure.

### 3.2 Data Processor

- 3.2.1 Reads and becomes familiar with this procedure before performing data processing.
- 3.2.2 Has successfully completed SIMS Level I training if using SCM Model III.
- 3.2.3 Reviews documentation (Attachment A or Attachment B) to ensure quality assurance measurements for a PSPC is performed according to this procedure.
- 3.2.4 Performs SRC and PBC analysis using data provided by the Operator(s) and updates appropriate SRC and PBC record and/or chart.
- 3.2.5 Per approval by the Project Manager, the Data Processor may also serve as the Operator.

### 3.3 Operator(s)

- 3.3.1 Reads and becomes familiar with this procedure before performing calibration measurements.
- 3.3.2 Has successfully completed SCM Level I training for the SCM model being used.

3.3.3 Performs all measurements according to this procedure. Records data on Attachment A or Attachment B.

## 4 DEFINITIONS AND ACRONYMS

**Table 1: Definitions and Acronyms**

Item	Description
NIST	National Institute of Standards and Technology
PBC	Performance based check
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity.
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.
SIMS	Survey Information Management System – SIMS is flexible and comprehensive interfacing software for the SCM. SIMS processes the SCM instrument data with a sophisticated data parser, integrated spreadsheet, and powerful special functions such as spatial data filters. SIMS provides the most flexible reporting system available for printing survey records or complete stand-alone survey reports. SIMS contains all the tools needed to meaningfully communicate between the SCM and the data analysis team. The main programs of the SIMS software are Stitcher, Visuspect, and Stracker.
SRC	Source response check

## 5 MATERIALS, EQUIPMENT, AND SOFTWARE

**Table 2: Materials, Equipment, and Software**

Item	Specification
Alpha or Beta Radioactive Source	High count rate alpha and beta sources with 100 cm <sup>2</sup> active areas are recommended. A total count rate in excess of 10,000 counts per minute is recommended. NIST-traceable sources are recommended.
PSPC	Typical lengths include 1 and 2 meters and can be constructed using metal or plastic. Custom lengths can be

Item	Specification
	manufactured based on project requirements.
SCM	Model III or IV.
SIMS	Stitcher v5.1n or higher; Visuspect v5.3l or higher; Stracker v2.0 or higher

## 6 PROCEDURE

- 6.1 Ensure the PSPC is purged per Reference 10.1. Note that step 6.2 can be completed while the PSPC is purging.
- 6.2 Ensure the SCM hardware is setup per Reference 10.2.
- 6.3 Ensure the SCM high voltage is set to the appropriate operating voltage(s) determined per Reference 10.3.
- 6.4 Ensure that the PSPC has been position calibrated per Reference 10.4.
- 6.5 If performing measurements utilizing the wheel encoder, ensure an encoder calibration and/or confirmation has been performed per Reference 10.5.
- 6.6 Ensure PSPC efficiency has been determined per Reference 10.6.
- 6.7 If using SCM Model III, continue to step 6.7.1 or if using SCM Model IV, continue to step 6.7.2.
  - 6.7.1 SCM III
    - 6.7.1.1 Record the SCM III, computer, electronics, and HV and LV pre-amplifier serial numbers in the Equipment Configuration table of Attachment A.
    - 6.7.1.2 Record the A and B LLD settings, operating voltage, PSPC type (e.g. T180), and Mylar thickness (nominally 0.85 mg/cm<sup>2</sup> unless the Project Manager specifies otherwise) on Attachment A.
    - 6.7.1.3 Record the speed, in inches per second, for a dynamic measurement or the static count time, in milliseconds, followed by the simulation speed (simuspeed) in parenthesis, for a static measurement on Attachment A.
    - 6.7.1.4 If a recount PSPC is utilized for this measurement, circle the appropriate method on Attachment A. Otherwise circle NA.
    - 6.7.1.5 Record the source isotope and serial number in the Equipment Configuration table of Attachment A.
    - 6.7.1.6 PBC filename nomenclature may be defined on a project by project basis. A recommended default name is to use a leading character

of A for alpha or B for beta, type the SCM serial number, enter the month and day as MMDD, enter the last digit of the year, then enter a sequential letter starting with A as the last character. For example, the first beta PBC measurement of February 1, 2006 on SCM #1 would be B102016A.

6.7.1.7 Continue to step 6.8.

#### 6.7.2 SCM IV

6.7.2.1 Record the PSE4 serial number and software suite version number in the Equipment Configuration table of Attachment B.

6.7.2.2 Record the minimum and maximum settings for both the left, right, and total discriminators on Attachment B.

6.7.2.3 Record the operating voltage, PSPC type (e.g. P90), Mylar thickness (nominally 0.85 mg/cm<sup>2</sup> unless the Project Manager specifies otherwise), and Coincidence Window setting on Attachment B.

6.7.2.4 Record the target speed, in centimeters per second, for a dynamic measurement or the static constant, in milliseconds, for a static measurement on Attachment B.

6.7.2.5 If a recount PSPC is utilized for the measurement, circle the appropriate method on Attachment B. Otherwise circle NA.

6.7.2.6 Record the source radionuclide and serial number in the Equipment Configuration table of Attachment B.

6.7.2.7 The Project Manager will determine the survey naming convention.

#### 6.8 Source Response Check Measurement

6.8.1 Perform all SRC measurements with the PSPC and source stationary in the center of the active area of the PSPC.

6.8.2 If using a recount array, ensure that both PSPCs are not shielded.

6.8.3 Record the SRC file name created on the computer.

6.8.4 Record the PSPC serial number on the SRC / Baseline Record table of Attachment A or Attachment B. If a recount array is being used, record serial numbers of both PSPCs.

6.8.5 If this SRC measurement is a baseline, check the box for each PSPC, as applicable, on the SRC / Baseline Record table of Attachment A or Attachment B.

6.8.6 With the SCM in *Static Mode* perform a one-minute background measurement.

- 6.8.7 Place the source on the center of the active area of the PSPC. Perform a one-minute source measurement.
- 6.8.8 Repeat step 6.8.7 for the second PSPC if using a recount array.
- 6.8.9 Remove the source from the PSPC.
- 6.8.10 Minimize the *SCM Program* and open *Report Generator*.
- 6.8.11 Select the SRC survey file name from the list and select *Process Data*.
- 6.8.12 Press *Continue* and on the following screen press *SRC Report*.
- 6.8.13 Note the location of the report and minimize the *Report Generator*.
- 6.8.14 Open *\_Reports* from the desktop and open the file folder noted in the previous step.
- 6.8.15 Open the file named *SRC-Report.txt*.
- 6.8.16 Record the values corresponding to the strip numbers from the SRC in the “Total Bkgd Counts” and “Total Source Counts” column of Attachment B.
- 6.8.17 Calculate and record the “Source Net Counts” by subtracting the “Total Bkgd Counts” from the “Total Source Counts”. Repeat for the second PSPC if using a recount array.
- 6.8.18 If this SRC measurement is not a baseline, enter the “Baseline Net Counts” value from Attachment A or Attachment B with the baseline values for this PSPC or recount array under the “Baseline Net Counts” column. Otherwise, enter N/A.
- 6.8.19 If this SRC measurement is not a baseline, calculate the percent difference using the equation below, and record the value under the “% Diff.” column of the SRC / Baseline Record table of Attachment A or Attachment B.  
$$\% \text{ Difference} = [(\text{Net} - \text{Baseline}) / \text{Baseline}] \times 100$$
- 6.8.20 Record the “Date Performed” on the SRC / Baseline Record table of Attachment A or Attachment B.
- 6.9 Performance Based Check Measurement
  - 6.9.1 Perform the PBC measurement with the PSPC or recount array operating the same as the surveys bounded by the PBC were/will be performed, e.g. survey speed, PSPC height, shielding, etc.
  - 6.9.2 Perform periodic PBCs throughout the course of the survey as specified by the Project Manager. Typically, PBCs are performed at the beginning of the shift, at least once per 4 hours of surveying, and at the completion of each shift. If there are surveys to be performed in difficult to return to areas, it is recommended to perform PBCs prior to and after the survey to bound the dataset to ensure quality of the data prior to demobilizing from the area.
  - 6.9.3 Perform all PBCs using the same source or a new control chart must be generated.

- 6.9.4 In order to minimize bias in the PBC measurement, ensure that the source locations are randomly selected at various axial positions along the detector.
  - 6.9.5 Record the filename on Attachment A for SCM Model III or survey name on Attachment B for SCM Model IV.
  - 6.9.6 Record any pertinent notes on Attachment A or Attachment B that will affect the data quality, e.g. equipment and P-10 changes, environmental factors, etc.
  - 6.9.7 Record the time the PBC was performed on Attachment A or Attachment B.
  - 6.9.8 Perform five (5) measurements in the same method as they will be performed during the survey, i.e. same geometry and survey speed or count time. The first three measurements should be documented in the control chart, with the remaining two available for use should any of the first three measurements be unusable.
  - 6.9.9 Provide electronic data and Operator(s) signed Attachment A or Attachment B to the Data Processor.
- 6.10 Data Processing and Review
- 6.10.1 The Data Processor will perform the remaining steps.
  - 6.10.2 If using the SIMS software, process the electronic data to determine the maximum 100 cm<sup>2</sup> data point for each of the five (5) strips. If using the SCM IV Report Generator, use PBC function for the selected PBC file. Add the first three usable data points to the control chart, creating a new chart if necessary.
    - 6.10.2.1 For PBCs, establish a control chart indicating the mean and 2-sigma and 3-sigma values. The number of measurements used to establish and “lock in” the control chart will be determined by the Project Manager.

NOTE: All surveys performed during the establishment of the control chart are performed at risk, as outliers are not always perceivable until the chart is established. This is particularly true for any data points that exceed 20% of the evolving control chart mean.
    - 6.10.2.2 Evaluate subsequent PBCs against the 2-sigma and 3-sigma criteria for indications of adverse trends.
  - 6.10.3 Evaluate the SRC data per the criteria provided in step 8.1.
  - 6.10.4 Evaluate the PBC data per the criteria provided in step 8.2.
  - 6.10.5 Provide the Data Processor signed Attachment A or Attachment B to the Project Manager.
  - 6.10.6 The Project Manager will review and sign Attachment A or Attachment B.

## **7 REQUIRED RECORDS**

- 7.1 Attachment A – PSPC Quality Assurance Worksheet – SCM Model III, or equivalent
- 7.2 Attachment B – PSPC Quality Assurance Worksheet – SCM Model IV, or equivalent

## **8 ACCEPTANCE CRITERIA**

- 8.1 Source Response Check
  - 8.1.1 For baseline SRCs, there are no acceptance criteria.
  - 8.1.2 Notify the Project Manager if a daily SRC percent difference is greater than 5%.
  - 8.1.3 Daily SRCs are acceptable if all percent difference from baseline measurement values are less than  $\pm 20\%$ . If a system fails to meet the acceptance criteria, the system should be removed from service until the failure is resolved.
- 8.2 Performance Based Check
  - 8.2.1 If more than one of the three measurements obtained during a PBC is greater than the 2-sigma or if any single measurement is greater than 3-sigma, the PBC and the data collected that is bounded by that PBC must be evaluated by the Project Manager or designee.
  - 8.2.2 Upon review from the Project Manager or designee, if in his professional judgment the dataset would cause the quality and results of the dataset to be in question, then all the survey data bounded since the last acceptable PBC shall be deemed as rejected. Also, the system should be removed from service until the failure is resolved.

## **9 RECORDS MANAGEMENT**

- 9.1 The Operator is responsible for recording data on Attachment A or Attachment B as appropriate. Once data collection is complete, the Operator will provide Attachment A or Attachment B and electronic records, as necessary, to the Data Processor.
- 9.2 The Data Processor is responsible for analyzing the data provided by the Operator and updating the appropriate PBC chart. Once the worksheet is complete, the Data Processor will provide Attachment A or Attachment B to the Project Manager.
- 9.3 The Project Manager will review the data on Attachment A or Attachment B and sign certifying the review. Attachment A or Attachment B should be located in a project file and archived after the project has been completed.

## **10 REFERENCES**

- 10.1 SCM-OPS-01, *PSPC Purging*
- 10.2 SCM-SETUP-02, *SCM Hardware Setup*

- 10.3 SCM-OPS-02, *PSPC Plateau Determination*
- 10.4 SCM-OPS-03, *PSPC Position Calibration*
- 10.5 SCM-OPS-04, *Encoder Calibration*
- 10.6 SCM-OPS-05, *PSPC Efficiency Calibration*

# ATTACHMENT A

## PSPC QUALITY ASSURANCE WORKSHEET – SCM MODEL III

### Equipment Configuration

<b>SCM III S/N:</b>		<b>Computer S/N:</b>	
<b>Electronics S/N:</b>		<b>HV Pre-amp S/N:</b>	
<b>LV Pre-amp S/N:</b>		<b>A/B LLD Settings (mV):</b>	/
<b>Operating Voltage (V):</b>		<b>PSPC Type (e.g. T180):</b>	
<b>Mylar Thickness (mg/cm<sup>2</sup>):</b>		<b>Speed (in./sec) or Count Time (msec):</b>	
<b>Recount Method (circle):</b>	Average / Gamma Subtraction / NA		
<b>Source Isotope:</b>		<b>Source Serial Number:</b>	

### SRC / Baseline Record

Check for Baseline	PSPC Type	PSPC Serial No.	Total Source Counts	Total BKG Counts	Net Counts	Baseline	% Diff.*	Time Performed
<input type="checkbox"/>								
<input type="checkbox"/>								
<input type="checkbox"/>								

### PBC Record

Filename	Notes**	Time

\* % Difference = [(Net – Baseline) / Baseline] × 100

\*\* List any equipment changes before this measurement, e.g. electronics, PSPC, P-10, etc.

### Data Review

Data Review	Name	Date	Signature
Operator			
Operator			
Data Processor			
Project Mgr.			

# ATTACHMENT B

## PSPC QUALITY ASSURANCE WORKSHEET – SCM MODEL IV

### Equipment Configuration

<b>PSE4 S/N:</b>		<b>Software Suite Version:</b>	
<b>Discrim. Left Min (mV):</b>		<b>Discrim. Left Max (mV):</b>	
<b>Discrim. Right Min (mV):</b>		<b>Discrim. Right Max (mV):</b>	
<b>Discrim. Total Min (mV):</b>		<b>Discrim. Total Max (mV):</b>	
<b>Operating Voltage (V):</b>		<b>PSPC Type (e.g. P90):</b>	
<b>Coincidence Window:</b>		<b>Target Speed (cm/sec) or Static Constant (msec):</b>	
<b>Recount Method (circle):</b>	Average / Gamma Subtraction / NA		
<b>Source Radionuclide:</b>		<b>Source Serial Number:</b>	

### SRC / Baseline Record

Check for Baseline	Survey Name	PSPC Serial No.	Total Bkgd Counts	Total Source Counts	Source Net Counts	Baseline Net Counts	% Diff.*	Date
<input type="checkbox"/>								
<input type="checkbox"/>								
<input type="checkbox"/>								

\* % Difference = [(Net – Baseline) / Baseline] × 100

**Note:** \_\_\_\_\_

### PBC Record

Survey Name	Notes**	Date	Time

\*\* List any equipment changes before this measurement, e.g. electronics, PSPC, P-10, etc.

### Data Review

Data Review	Name	Date	Signature
Operator			
Operator			
Data Processor			
Project Mgr.			

**Millennium Services, Inc.**

**Survey Procedure**

SCM-SETUP-01, Rev. 0

PSPC Repair

Effective Date: 01/17/08

A handwritten signature in black ink, appearing to read "Priddy", is written over the signature line.

Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08

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## **1 PURPOSE**

This procedure details the tasks required to repair a position sensitive proportional counter (PSPC).

## **2 SCOPE**

This procedure applies to the aluminum and plastic PSPCs. Completion of all or some of the tasks listed is required to repair the PSPC. Individual technique is achieved by hands on experience in the presence of an experienced PSPC repairer. PSPC repair should be performed in a well lighted and ventilated room. A PSPC will need repair when any of the following conditions are met or when unexpected operation cannot be corrected:

- A hole or tear in the Mylar face is larger than what a single, short piece of cellophane tape can reasonably repair in the field.
- More than 10% of the surface of the Mylar has been covered with cellophane tape from field repairs.
- The anode wire has broken.
- Survey data or SCM operator indicates a corona point is identified when using the PSPC.
- Any PSPC hardware is damaged, e.g. MHV or gas line connectors, which causes the PSPC to be unable to be used for survey.
- Considerable amounts of P-10 gas leak from the PSPC and cannot be field repaired, e.g. the MHV and gas line connectors or PSPC housing welds.
- A minimum of 60 cc/min cannot be maintained on the out-flow gauge with an acceptable in-flow gauge setting as determined by the Project Manager.

A repaired PSPC may be returned to service after successfully completing the certification process outlined in step 6.6.

## **3 RESPONSIBILITIES**

### **3.1 Project Manager**

- 3.1.1 Reads and becomes familiar with this procedure.
- 3.1.2 Ensures all materials, equipment and supplies are available.
- 3.1.3 Periodically reviews PSPC Repair Log (Attachment C), if used, to identify trends that may affect project performance, e.g. recurring inadequate repairs.

### **3.2 Operator**

- 3.2.1 Reads and becomes familiar with this procedure before performing PSPC repair.

3.2.2 Has successfully completed SCM Level I and Level II training.

3.2.3 Performs all tasks according to this procedure. Records data on Attachments A, B, and C as required. Equivalent forms may be used.

#### 4 DEFINITIONS AND ACRONYMS

**Table 1: Definitions and Acronyms**

Item	Description
cc/min or ccm	Cubic centimeters per minute
MHV	High voltage connector used with co-axial cables. Connector has center pin connected to the center cable conductor and a metal tube connected to the outer cable shield. A rotating ring outside the tube locks the cable to any female connector.
MSDS	Material Safety Data Sheet
P-10 Gas	90% argon / 10% methane gas mixture used in PSPC. Ultra high purity quality is recommended.
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity. A trapezoidal PSPC is used for dynamic (rolling) surveys and a corner PSPC is used for static (corner) surveys.
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.
SRA	Shonka Research Associates, Inc.
SRAPA	SRA Position Analyzer

#### 5 MATERIALS, EQUIPMENT, AND SOFTWARE

**Table 2: Materials, Equipment, and Software**

Item	Specification
Abrasive Pads	Non-Specific: Industry standard steel wool, Teflon, Scotch Brite and/or other
Adhesive, Quick Drying *	Non-Specific: Multipurpose

<b>Item</b>	<b>Specification</b>
Air, Pressurized *	Non-Specific: Spray can type used to clean electronics
Alcohol, Isopropyl *1	Non-Specific: Antiseptic type
Butane, Pressurized *	Non-Specific: Brand suitable for use with soldering iron
Connectors, MHV	Pasternack Enterprises brand
Flow meter	Non-Specific: Rotometer Type with cc/min
Files, Metal	Non-Specific: Typical sizes suited for moderate and fine metal finishing
Gas Detector	Non-Specific: MSHA Approved
Hammer	Non-specific: Suitable for pounding minor dents from Aluminum
Iron, Soldering	Non-Specific: Typical size
Multimeter-OHM Meter	Non- Specific: Industry standard
Mylar	Typically Alexander Vacuum Research, Inc., Part Number C(2), Gauge 0.00024 in, density thickness 0.85 mg/cm <sup>2</sup> ; specifications determined by Project Manager
P-10 Gas *	90% argon / 10% methane gas mixture used in PSPC. Ultra high purity quality is recommended.
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity. A trapezoidal PSPC is used for dynamic (rolling) surveys and a corner PSPC is used for static (corner) surveys.
Purge Station	To perform the leak test portion of the PSPC certification, it is recommended to setup a dedicated purge station. The purge station requires P-10 gas, a regulator, a flow meter with flow-in and flow-out gauges, and tubing. Setup of the purge station is beyond the scope of this procedure. An SCM can be used for the certification rather than a dedicated purge station.
Regulator	Non-Specific: Compatible with P-10 cylinders
Paint brush	Non-Specific: Industry standard small size for solvent application to residual tape residue

<b>Item</b>	<b>Specification</b>
Q-Dope *	Protective coating type for coils and transformers; a thinner may be needed to thin the Q-Dope prior to application
Razor Blades	Non-Specific: Industry standard
Razor Knife	Non-Specific: Industry standard
Sandpaper	Non-Specific: Industry standard. Typical sizes suited for moderate and fine metal finishing.
Tweezer	Non-Specific: Multipurpose
Scissors	Non-Specific: Multipurpose
SCM	Model III
Solder	3.5 – 4.0% Silver & 96.0% – 96.5% Tin (e.g., Oatey #53013 or RadioShack #64-026)
Soldering Iron	Non-Specific: Brand with 1/8” tip suitable for heating MHV connectors
Solvent *	Industry standard adhesive removal specific
Steel Wool	Non-Specific: Industry standard
Tape, Cellophane	Non-Specific: Industry standard
Tape, Double-sided	Metal Detectors: 3M Scotch 9425 ¾” wide Plastic Detectors: 3M Scotch 969 ¼” wide Non-Specific: Industry standard, ¾” or wider
Tape, Electrical	Non-Specific: Industry standard
Tape, Duct	Non-Specific: Industry standard
Tape, Nylon	Non-Specific: Industry standard
Weld, Aluminum *	Non-Specific: Industry standard. Typical brand such as “JB Weld” is acceptable.
Wipes, Dry Absorbent	Non-Specific: Industry standard
Wire, Steel (Anode)	STABLOHM 800 B, Size .001, TARE 66.560
Wrench	Non-Specific: Industry standard; typical ½” size is acceptable

\*MSDS Required

## 6 PROCEDURE

**Note: Section 6.1.1 is intended for large survey projects involving 10 or more detectors. The Project Manager will decide whether to implement this section.**

### 6.1 PSPC Tagging

#### 6.1.1 Repair Tags

- 6.1.1.1 The front of a repair tag (Attachment A or equivalent) will be completed whenever a PSPC is removed from service or received into inventory from any location. The repair tag will be attached to the PSPC.
- 6.1.1.2 After repairs are completed, the back of the repair tag will be completed. The repair tag will remain affixed to the PSPC.
- 6.1.1.3 The repair tag will be removed from the PSPC only to attach another repair tag or to attach a certification tag (Attachment B or equivalent).
- 6.1.1.4 The removed repair tag will be placed in the repair tag bin. The information on the repair tag will be transcribed into the repair log (Attachment C or equivalent). The repair tag can be filed or discarded at the discretion of the Project Manager.
- 6.1.1.5 Repair tags are recommended to be colored red.

#### 6.1.2 Certification Tags

- 6.1.2.1 The certification tag should be filled out during the certification process outlined in step 6.6. The certification tag will be attached to the PSPC.
- 6.1.2.2 The PSPC will be considered in service and can be used for surveys only with a valid certification tag.
- 6.1.2.3 When the PSPC is used for a survey, the certification tag will be removed. The certification tag can be filed or discarded at the discretion of the Project Manager.
- 6.1.2.4 Certification tags are recommended to be colored green.

### 6.2 PSPC Preparation

- 6.2.1 Remove existing Mylar and all tape used on the PSPC.
- 6.2.2 Inspect the anode wire for nicks, crimps, or contamination.

**Note: If the anode wire is intact, crimp free, and free of contamination, it may be reused, as long as it passes the resistance test. Do not touch, damage, or break it. Perform the resistance check as described in steps 6.6.1 through 6.6.4. If it meets the acceptance criteria, it can be reused.**

**The anode wire cannot be reused if it comes into contact with any foreign substance during repair.**

6.2.3 Remove tape residue.

6.2.3.1 Metal Detector

Apply acetone or acceptable solvent to tape residue.

As the tape residue absorbs the acetone or solvent, quickly remove with soft even strokes of a flat razor being careful not to gouge or nick the PSPC.

6.2.3.2 Plastic Detectors

The tape should remove cleanly. Any residue should be removed by rubbing with your thumb.

**Note: Tape may not have to be removed if all tape is left intact when Mylar is removed. Additional layers of tape may be added as well.**

**Note: If you are unable to remove the tape by rubbing, solvent may be used to loosen the tape; however, any damage to the painted surface will require factory refurbishment.**

**Note: DO NOT attempt to remove tape by scraping with a tool.**

6.2.4 Inspect PSPC housing for damage including, but not limited to, burrs, dents, cracks, broken brackets, and loose MHV and gas line connectors. If a MHV or gas line connector is damaged, remove connector to be replaced as described in step 6.3 below.

6.2.5 Repair any defects noted in the detector housing.

6.2.5.1 Metal Detector

Remove from the PSPC housing any large burrs with a file and any small burrs with sandpaper, steel wool, or an abrasive pad. If the anode wire can be used, use caution when removing PSPC housing burrs so as not to damage or contaminate the anode wire. Do not touch or break the anode wire and keep all shavings away.

If the anode wire needs to be replaced, remove from the PSPC housing any large burrs with a file and any smaller burrs with sandpaper, steel wool, or an abrasive pad. If anode wire can be reused, use caution when removing PSPC housing burrs as not to damage the anode wire. Do

not touch or break the anode wire and keep all shavings away.

Repair only minor dents by pounding with a hammer. For large dents or dents that will result in gas leaks, remove the PSPC from service.

Repair minor cracks in PSPC housing seams using aluminum weld. If the weld does not hold or the PSPC has broken brackets, remove the PSPC from service.

#### 6.2.5.2 Plastic Detector

Smooth out any areas of the detector with flaking paint by lightly rubbing with a soft cloth, ensuring any residue is not deposited on the anode wire.

Small cracks in the detector may be repaired using adhesive, but given the relative cost of the plastic detectors it is generally easy to salvage the MHV connectors and dispose of the detector housing.

Touch up the conductive paint in any areas that are abraded or showing signs of wear, allowing paint to fully dry before continuing.

- 6.2.6 Tighten any loose MHV and gas line connectors by turning or using a wrench of the appropriate size.

**Note: If the anode wire is intact, tightening the MHV connectors will require the anode wire to be replaced.**

- 6.2.7 Remove loose debris using a can of pressurized air and clean Mylar contact surfaces using dry absorbent wipes and rubbing alcohol.

**Note: If anode wire is intact, follow the same procedure but clean only accessible surfaces and avoid touching or breaking the wire.**

- 6.2.8 Clean MHV connectors, only if the anode wire is not intact. To clean the MHV, melt the residual solder, Q-Dope, and anode wire remnants with soldering iron. While not recommended, the MHV connector may be removed from the PSPC housing prior to cleaning. If removed for cleaning, reinstall MHV connectors as described in step 6.3 below.

### 6.3 Connector Installation

- 6.3.1 Wrap threads of connector with nylon tape.
- 6.3.2 Install connection into PSPC; o-ring should be secured within the bulkhead fitting.
- 6.3.3 Tighten connection.
- 6.3.4 Repeat step 6.3 as necessary for each connector.

## 6.4 Anode Wire Installation

**Note: The anode wire is extremely delicate and should be handled carefully. Anode wire running between MHV posts should not be touched with hands or tools that will leave any residue. The anode wire spool should be considered delicate; it should be handled carefully and always kept in its packaging when not in use.**

6.4.1 Wrap a piece of cellophane tape around end of anode wire for manipulation and visibility.

6.4.2 Without touching anode wire and starting with the spool of wire toward the center of the PSPC, wrap the wire around center of MHV post one and a half times.

**Note: A small amount of pre-solder placed on the pole may ease the difficulty of wrapping the wire around the center of the MHV post.**

6.4.3 Secure loose end of anode wire to PSPC flange with cellophane tape.

6.4.4 With the spool pulling the wire taut, solder the pole/anode wire connection.

6.4.5 Keeping the wire under delicate tension, unspool the anode wire down the remaining length of the PSPC. Do not touch or kink the wire. A pen or pencil is recommended to aid in unspooling the wire.

6.4.6 Wrap the wire around center of the second MHV post one and a half times.

**Note: A small amount of pre-solder placed on the pole may ease the difficulty of wrapping the wire around the center of the MHV post.**

6.4.7 Secure anode wire to PSPC flange with cellophane tape.

6.4.8 The wire should be taut under delicate tension. The wire is secure if it does not vibrate when sprayed with canned air.

6.4.9 Cut the spool free of the wire taped to the flange.

6.4.10 Solder the second pole/anode wire connection.

6.4.11 For each pole/anode wire connection, re-heat the solder to create a stronger bond between the solder, MHV post, and anode wire. Solder joint must be smooth and free from any sharp edges.

6.4.12 Allow the solder to cool for at least one minute.

6.4.13 Cut the wire ends running from the poles flush with the solder connection.

6.4.14 Inspect both solder joints with a magnifying glass to ensure the wire and solder will not produce a potential corona point.

6.4.15 Check anode wire resistance for acceptability as outlined in steps 6.6.1 through 6.6.4 - resistance data should be recorded on the back of the repair tag rather than the certification tag at this stage of PSPC repair. This check is done now solely to identify anode wire problems before Mylar face

installation. The anode wire resistance should always be checked prior to mylar installation.

- 6.4.16 Apply Q-Dope over the solder joints. Be careful not to apply any Q-Dope to the anode wire. The Q-Dope will serve as additional protection against corona points from anode pig tails or solder.

## 6.5 Mylar Installation

### 6.5.1 Mylar Preparation

- 6.5.1.1 On a long, smooth, and clean surface, unroll a length of Mylar six inches longer than the PSPC. The Project Manager will determine the specific density thickness, in  $\text{mg}/\text{cm}^2$ , of Mylar to install. Typically Mylar of  $0.85 \text{ mg}/\text{cm}^2$  density thickness will be required.
- 6.5.1.2 Secure the Mylar by placing two pieces of cellophane tape at each end; position the tape as to stretch the Mylar's length and width taut.
- 6.5.1.3 Place additional cellophane tape 6 to 12 inches apart along the length of each side of the Mylar, stretching the length and width of the Mylar.

### 6.5.2 Trapezoidal PSPC

- 6.5.2.1 Apply double-sided tape to the two shorter length sides of the PSPC. The tape should be applied to the full length of each flange and applied such the tape's edge matches the flange's outer edge.
- 6.5.2.2 Press double-sided tape strips firmly into place.
- 6.5.2.3 Remove the tape backing.
- 6.5.2.4 Apply double-sided tape to the two longer length sides of the PSPC. The tape should be applied to the full length of each flange and applied such the tape's edge matches the flange's outer edge and overlap the previously two applied strips of double-sided tape.
- 6.5.2.5 Press double-sided tape strips firmly into place.
- 6.5.2.6 Remove the tape backing.
- 6.5.2.7 Apply a small amount of quick drying adhesive to the four inside corners where the double-sided tape strips overlap. The adhesive should be applied at least five centimeters from each corner along the tape. The adhesive will serve as a seal for the transition between the flange and overlapping double-sided tape.
- 6.5.2.8 Lift PSPC, invert with sticky side of double-sided tape facing down, and align over Mylar.
- 6.5.2.9 Carefully lower PSPC onto Mylar in one motion. Avoid lateral motion of the PSPC.

- 6.5.2.10 Apply pressure (push down with hands) to length of PSPC to allow the double-sided tape to uniformly adhere to the Mylar.
  - 6.5.2.11 With PSPC still inverted, use a razor blade or other sharp cutting tool and trim excess Mylar up to the edges of PSPC.
  - 6.5.2.12 Turn PSPC over and with fingers, smooth out as many air bubbles as possible from flange. Remaining air bubbles can be removed by piercing each bubble with a sharp point as long as they are not too close to the inner edge of the PSPC.
  - 6.5.2.13 Secure Mylar by placing four strips of duct tape along each PSPC flange. Firmly wrap duct tape around PSPC flange. Trim excess duct tape on top of flange as necessary
- 6.5.3 Corner PSPC
- 6.5.3.1 Begin by applying double-sided tape to the top of the PSPC's sidewall. Vertically align the tape high enough on the outside wall to over lap the top edge of the open face's sidewalls and cover the entire top surface of that side. Provide the same amount of overlap at the ends of the PSPC (even though the top edge is a wide flange).
  - 6.5.3.2 Continue application of the double-side tape around all the PSPC corners until you arrive near the starting point.
  - 6.5.3.3 Remove the first few inches of the double-sided tape backing from the beginning of the strip.
  - 6.5.3.4 Apply a small amount of quick drying adhesive to the beginning edge of the double-sided tape. The adhesive will serve as a seal for the transition between the flange and overlapping double-sided tape.
  - 6.5.3.5 Cut excess double-sided tape and apply the end of the tape to overlap the beginning of the strip.
  - 6.5.3.6 Apply a small amount of quick drying adhesive to the ending edge of the double-sided tape. The adhesive will serve as a seal for the transition between the ends of the overlapping double-sided tape.
  - 6.5.3.7 Apply double-sided tape on the end flanges at each end of the PSPC and bend over the sides of the PSPC.
  - 6.5.3.8 Remove the backing from all applied double-stick tape.
  - 6.5.3.9 Apply a small amount of quick drying adhesive to the exterior corners where the two layers of double-sided tap overlap. The adhesive will serve as a seal for the transition between the overlapping strips of double-sided tape.
  - 6.5.3.10 Lift PSPC, invert with sticky side of double-sided tape on the end flanges facing down, and align over Mylar.

- 6.5.3.11 Carefully lower PSPC onto Mylar in one motion. Avoid lateral motion of the PSPC.
- 6.5.3.12 Apply pressure (push down with hands) to length of PSPC to allow the double-sided tape to uniformly adhere to the Mylar.
- 6.5.3.13 Carefully trim a three centimeter border of Mylar around three sides of the PSPC with a razor blade or knife.
- 6.5.3.14 Gently pull the Mylar and apply to the PSPC sidewall. Applying the Mylar smoothly will prevent folds or channels from developing in the Mylar-Tape seal.
- 6.5.3.15 Turn PSPC over and with firm downward moving thumb motions, smooth the Mylar to the double-sided tape around entire edge of PSPC.
- 6.5.3.16 Trim excess Mylar from the fourth side.
- 6.5.3.17 Excess Mylar at the corners of the PSPC should be folded into a triangle and applied to the PSPC sidewall with fast drying adhesive.
- 6.5.3.18 Apply electrical tape on top of Mylar over all the areas with double-sided tape underneath.
- 6.5.3.19 Apply a second continuous strip of electrical tape around the entire length of the PSPC sidewall offset half the width of the first electrical tape strip, away from the Mylar.
- 6.5.4 Plastic PSPC
  - 6.5.4.1 Apply double sided tape (Scotch 969) to the detector flange. Tape should not cover the outside 1/16<sup>th</sup> inch or edge of the detector flange.
  - 6.5.4.2 Remove the backing from all applied double-stick tape.
  - 6.5.4.3 Lift PSPC, invert with sticky side of double-sided tape facing down, and align over Mylar.
  - 6.5.4.4 Carefully lower PSPC onto Mylar in one motion. Avoid lateral motion of the PSPC.
  - 6.5.4.5 Apply pressure (push down with hands) to length of PSPC to allow the double-sided tape to uniformly adhere to the Mylar.
  - 6.5.4.6 Carefully trim the mylar from the detector leaving a ¼ inch mylar border around the detector.
  - 6.5.4.7 Invert the detector and press the mylar firmly against the detector flange.
  - 6.5.4.8 Apply one inch wide tape to the mylar over the flanges, aligning the inside edge of the tape with the inside edge of the flange.

- 6.5.4.9 Press tape and ¼ inch mylar border around flange and secure to the detector side wall to ensure mylar contact with the outside flange edge.
- 6.5.4.10 Apply additional tape at each corner to form “hospital corners”.
- 6.5.5 Note the Mylar density thickness installed, in mg/cm<sup>2</sup>, on the back of the repair tag, if used.
- 6.5.6 Initial and date repair tag, if used.
- 6.5.7 Attach repair tag to PSPC, if used, if tag was removed.
- 6.6 PSPC Certification
  - 6.6.1 Turn PSPC facing downward.
  - 6.6.2 Turn the multimeter on and set to Ohms.
  - 6.6.3 Insert the black cable (negative) into one MHV terminal and the red cable (positive) into the other. The resistance must be within  $\pm 0.03$  kOhms from the nominal resistance based on PSPC length provided in Table 3 below by PSPC type. An MHV cable can be used to extend the length of multimeter connection. If the measured resistance is not acceptable, troubleshoot the anode wire installation. If the performance cannot be corrected, remove and reinstall the anode wire. Record the data on the certification tag.

**Table 3: Anode Wire Acceptable Resistance Ranges**

PSPC Type	PSPC Length (cm)	Nominal Resistance (kOhms)
Corner	90	2.3
Trapezoidal	110	2.4
Corner	180	4.7
Trapezoidal	200	5.2
P100	100	2.57
P40	40	1.03

- 6.6.4 Resistance from MHV to ground should be infinite (multimeter will read OL for over load). Test each MHV terminal by inserting the black cable (negative) into the MHV terminal and touching the red cable (positive) to the PSPC housing. If the multimeter does not read OL, troubleshoot the anode wire installation. If the performance cannot be corrected, remove and reinstall the anode wire. Record the data on a blank certification tag.
- 6.6.5 Connect the PSPC to the purge station.
- 6.6.6 Open valve on P-10 gas bottle. For adjustable regulators, set the regulator’s secondary gauge to 10 psi nominal pressure.
- 6.6.7 Flow P-10 into the detector at a rate of 100 to 120 cc/min. Wait several minutes for the outlet flow gauge to confirm flow. If the outlet flow gauge

does not rise or is significantly less than the inlet flow gauge, there is a gas leak. Locate the leak using a gas detector. If a leak occurs on the PSPC, attempt to repair.

6.6.8 Note the outlet flow gauge reading. If the reading is less than 60 cc/min, the PSPC requires additional repair. If the reading is acceptable, note the value on the certification tag.

6.6.9 Remove the repair tag and place in the repair tag bin.

6.6.10 Initial and date the certification tag and attach to the PSPC.

6.6.11 The PSPC can now be returned to service.

## **7 REQUIRED RECORDS**

**Note: Attachments A and C are only required if the Project Manager decided to implement Section 6.1.1 of this procedure.**

7.1 Attachment A – PSPC Repair Tag

7.2 Attachment B – PSPC Certification Tag

7.3 Attachment C – PSPC Repair Log

## ATTACHMENT A

### PSPC REPAIR TAG

<b>PSPC REPAIR</b>	Repair Request:	<hr/>			
		<hr/>			
	SN:	<hr/>			
	Type:	C90 <input type="checkbox"/>	T90 <input type="checkbox"/>	C180 <input type="checkbox"/>	T180 <input type="checkbox"/>
	Material:	Metal <input type="checkbox"/> Plastic <input type="checkbox"/>			
	Initials:	<hr/>	Date:	<hr/>	
		(front)			

<b>PSPC REPAIR</b>	Repairs Completed:	<hr/>			
		<hr/>			
	Resistance:	<hr/>	kOhms MHV to MHV		
	Resistance:	HV MHV OL <input type="checkbox"/>		LV MHV OL <input type="checkbox"/>	
	Initials:	<hr/>	Date:	<hr/>	
		(back)			

**ATTACHMENT B**  
**PSPC CERTIFICATION TAG**

**PSPC CERTIFICATION**

Resistance: \_\_\_\_\_ kOhms MHV to MHV

Resistance: HV MHV OL ☐ LV MHV OL ☐

Leak Test: \_\_\_\_\_ in cc/m \_\_\_\_\_ out cc/m

Initials: \_\_\_\_\_ Date: \_\_\_\_\_

# ATTACHMENT C

## PSPC REPAIR LOG

[illegible]

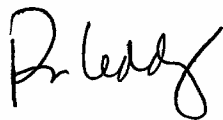
**Millennium Services, Inc.**

**Survey Procedure**

SCM-SETUP-02, Rev. 0

Hardware Setup

Effective Date: 01/17/08

A handwritten signature in black ink, appearing to read "Priddy", is written over the signature line.

Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08

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## **1 PURPOSE**

This procedure details the requirements for hardware setup of the Surface Contamination Monitor (SCM).

## **2 SCOPE**

This procedure applies to SCM Models III and IV.

## **3 RESPONSIBILITIES**

### **3.1 Project Manager**

3.1.1 Reads and becomes familiar with this procedure.

3.1.2 Has successfully completed SCM Level I training for the SCM model being used.

### **3.2 Operator**

3.2.1 Reads and becomes familiar with this procedure.

3.2.2 Has successfully completed SCM Level I training for the SCM model being used.

## **4 DEFINITIONS AND ACRONYMS**

**Table 1: Definitions and Acronyms**

<b>Item</b>	<b>Description</b>
HV	High-voltage
Isobar®	Trade name for a 110 VAC line conditioner. SCM III electronics are plugged into the conditioned side.
LLD	Lower-level discriminator
LV	Low-voltage
OV	Operating voltage

Item	Description
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity.
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.
SRA	Shonka Research Associates, Inc.

## 5 MATERIALS, EQUIPMENT, AND SOFTWARE

**Table 2: Materials, Equipment, and Software**

Item	Specification
<b>General</b>	
PSPC	Typical lengths include 1 and 2 meters and can be constructed using metal or plastic. Custom lengths can be manufactured based on project requirements.
SCM	Model III or IV.
<b>SCM Model III</b>	
Circuit Tester	GB Electrical GRT-500, or equivalent
Extension Cord	Minimum gauge as follows: 14 for up to 50', 12 for an additional 100', and 10 for any greater length. Project Manager will define maximum total extension cord(s) length.
SCM Process Software	Version 2.0 or later
Small Flat-Head Screwdriver	Jeweler's-sized screwdriver for adjusting SCM Model III electronics
<b>SCM Model IV</b>	
Battery	Kendrick Astro Instruments Power Pack 12V 33AH, or equivalent
Powerbase	12 Volt DC 7500 mAh, Model DVL-9000Y, or equivalent

Item	Specification
PSE4	SCM IV Electronics, Revision C: DSP Firmware 03/08/06 B#267 Atmel Firmware Build # 29 External Power Supply (Revision 1a)

## 6 PROCEDURE

### 6.1 SCM Model III

- 6.1.1 Ensure the SCM hardware is powered off.
- 6.1.2 Test the 110 V power supply using the circuit tester as follows. An acceptable power source will be indicated by two illuminated yellow lights.
  - 6.1.2.1 Test the power supply outlet for acceptability.
  - 6.1.2.2 Plug an extension cord into the tested outlet. Test the extension cord for acceptability. Repeat this step for each extension cord used.
  - 6.1.2.3 Power on the isobar® outlet and test an isobar® outlet for acceptability.
  - 6.1.2.4 Be sure to retest the power supply, outlet, extension cord(s), and isobar® if the SCM is moved to a new location.
- 6.1.3 Ensure the SCM is properly grounded. Auxiliary grounding wire or cabling may be required. Consult the Project Manager for proper setup. Note that changing the SCM's location may alter the grounding setup.
- 6.1.4 Connect the HV and LV pre-amp modules.
 

For a single PSPC, the HV end should be to the left as viewed from the operator's position. The red connection corresponds to the HV end and the blue connection corresponds to the LV end of the PSPC. Connect the HV to the left side of the PSPC and connect the LV to the right side of the PSPC.

For a PSPC array, the primary PSPC will be in front and the HV end will be to the left as viewed from the operator's position. The secondary PSPC will be in back of the primary PSPC. Connect a MHV jumper cable to the right hand side of both PSPCs. Connect the HV to the left side of the primary PSPC and connect the LV to the left side of the secondary PSPC.
- 6.1.5 Power on the computer, pause a couple of seconds, then power on the SCM electronics.
- 6.1.6 Ensure the LLD-A and LLD-B are set to 25 mV and the alpha and beta HV are set as determined by the Project Manager per Reference 7.1.

## 6.2 SCM Model IV

### 6.2.1 Backpack Mode

- 6.2.1.1 Ensure the SCM hardware is powered off.
- 6.2.1.2 Disconnect AC chargers from all sources (12 V battery, powerbase and computer).
- 6.2.1.3 Connect the HV and LV MHV cables, labeled *Right* and *Left*, respectively, to the PSE4.

For a single PSPC, the HV end should be to the left as viewed from the operator's position. The red connection corresponds to the HV end and the blue connection corresponds to the LV end of the PSPC. Connect the HV to the left side of the PSPC and connect the LV to the right side of the PSPC.

**Note: A PSPC array is not supported with the current SCM Model IV design.**

- 6.2.1.4 Connect PSPC mounted encoder and data acquisition pendant, as needed.
- 6.2.1.5 Power on the computer and wait for the Windows welcome screen to appear.
- 6.2.1.6 Power on the SCM electronics in the following sequence: Connect USB cable from PSE4 to computer and then turn on the power base.

A successful connection is indicated by a "Waiting for Host Connection" message on the PSE4 display. Error messages may occur if the sequence is not followed. To correct the problem power off the powerbase and follow the correct sequence.

### 6.2.2 Tethered Mode

- 6.2.2.1 Ensure the SCM hardware is powered off.
- 6.2.2.2 Disconnect AC chargers from all sources (12 V battery, powerbase and computer).
- 6.2.2.3 Connect the HV and LV MHV cables, labeled *Right* and *Left*, respectively, to the PSE4.

For a single PSPC, the HV end should be to the left as viewed from the operator's position. The red connection corresponds to the HV end and the blue connection corresponds to the LV end of the PSPC. Connect the HV to the left side of the PSPC and connect the LV to the right side of the PSPC.

**Note: A PSPC array is not supported with the current SCM Model IV design.**

- 6.2.2.4 Connect PSPC mounted encoder and data acquisition pendant, as needed.
- 6.2.2.5 Power on the computer and wait for the Windows welcome screen to appear.
- 6.2.2.6 Power on the SCM electronics in the following sequences as specified for the computer location:
  - A. Computer is not connected to docking station:
    - 1) Connect USB cable from PSE4 to computer and then turn on the power base.
  - B. Computer is connected to docking station:
    - 1) Connect USB cable from PSE4 to computer and then turn on the powerbase.
    - 2) Connect the computer power supply to a 5 amp (minimum) DC receptacle on the 12 volt battery. This will prevent depletion of the computer's internal battery.

A successful connection is indicated by a "Waiting for Host Connection" message on the PSE4 display. Error messages may occur if the sequence is not followed. To correct the problem power off the powerbase and follow the correct sequence.

### 6.2.3 Cart Mode

- 6.2.3.1 Ensure the SCM hardware is powered off.
- 6.2.3.2 Disconnect AC chargers from all sources (12 V battery, powerbase and computer).
- 6.2.3.3 Connect the HV and LV MHV cables, labeled *Right* and *Left*, respectively, to the PSE4.

For a single PSPC, the HV end should be to the left as viewed from the operator's position. The red connection corresponds to the HV end and the blue connection corresponds to the LV end of the PSPC. Connect the HV to the left side of the PSPC and connect the LV to the right side of the PSPC.

**Note: A PSPC array is not supported with the current SCM Model IV design.**

- 6.2.3.4 Connect PSPC mounted encoder and data acquisition pendant, as needed.
- 6.2.3.5 Power on the computer and wait for the Windows welcome screen to appear.
- 6.2.3.6 Power on the SCM electronics in the following sequence:

- A. Connect USB cable from PSE4 to computer and then turn on the power base.

A successful connection is indicated by a “Waiting for Host Connection” message on the PSE4 display. Error messages may occur if the sequence is not followed. To correct the problem power off the powerbase and follow the correct sequence.

- B. Connect the computer power supply cable to a 5 amp (minimum) DC receptacle on the 12 volt battery. This will prevent depletion of the computer’s internal battery.

- 6.2.3.7 Connect the cart motor power supply cable to a 10 amp (minimum) DC receptacle on the 12 volt battery.

## **7 REFERENCES**

- 7.1 SCM-OPS-02, *PSPC Plateau Determination*

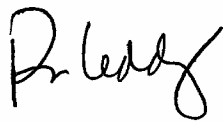
**Millennium Services, Inc.**

**Survey Procedure**

SCM-SETUP-03, Rev. 0

Quality Assurance Testing of SCM

Effective Date: 01/17/08

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Approved by: \_\_\_\_\_

## REVISION HISTORY

<b>Rev #</b>	<b>Reason for Revision</b>	<b>Approval Date</b>
0	Original Procedure	01/17/08

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## 1 PURPOSE

The SCM is a complicated and highly interactive survey instrument. Subtle changes in one of the SCM components can potentially affect many other systems within the SCM, rendering it unfit for survey use. In order to minimize time lost in the field repairing an SCM, a number of SCM Quality Assurance (QA) tests are performed prior to deployment. These checks are designed to identify problems generated by both intentional and unintentional changes to the SCM, damage or changes from previous surveys that were not noticed upon return, and the effects of long term storage between surveys.

## 2 SCOPE

These QA tests should be performed on every SCM system before it is released for general use or deployed on a survey.

## 3 RESPONSIBILITIES

### 3.1 Operator

3.1.1 Reads and becomes familiar with this procedure before performing check out.

3.1.2 Has successfully completed SCM Level II training.

3.1.3 Performs measurements in accordance with this procedure.

## 4 DEFINITIONS AND ACRONYMS

**Table 1: Definitions and Acronyms**

Item	Description
Incremental Encoder	Electronic device used to measure rotation.
PBC	Performance based check
PSPC	Position Sensitive Proportional Counter – This is a radiation detector that is capable of establishing where along the detector a pulse is sensed. The system is described in NUREG/CR-6450. The detectors are similar in efficiency to other counters, but have backgrounds associated with small area detectors (5 cm × 5 cm). This results in improved sensitivity, due to low background, and specific identification of the location of the radioactivity.
SCM	Surface Contamination Monitor – A mobile platform containing detectors, support electronics, and a data logger used for conducting radiological surveys.

Item	Description
SIMS	Survey Information Management System – SIMS is flexible and comprehensive interfacing software for the SRA SCM. SIMS processes the SCM instrument data with a sophisticated data parser, integrated spreadsheet, and powerful special functions such as spatial data filters. SIMS provides the most flexible reporting system available for printing survey records or complete stand-alone survey reports. SIMS contains all the tools needed to meaningfully communicate between the SCM and the data analysis team. The main programs of the SIMS software are Stitcher, Visuspect, and Stracker.
SRAPA	SRA Position Analyzer software
SRC	Source response check
Survey Speed	Anticipated target survey speed

## 5 MATERIALS, EQUIPMENT, AND SOFTWARE

**Table 2: Materials, Equipment, and Software**

Item	Specification
Check Source	100 cm <sup>2</sup> Co-60, Cs-137 or equivalent as directed by expected Project Manager.
Circuit Tester	GB Electrical GRT-500, or equivalent, for SCM Model III
Isobar®	Trade name for a 110 VAC line conditioner. SCM Model III electronics are plugged into the conditioned side.
Lift Assembly	Modular SCM add-on component that can elevate a detector. Note: only needed if it is to be used during the upcoming survey.
Point Source	Am-241 or equivalent collimated point source
PSPC	Typical lengths include 1 and 2 meters and can be constructed using metal or plastic. Custom lengths can be manufactured based on project requirements.
SCM	SCM Model IV: Wearable Survey System Revision A or later SCM Model III: Revision A or later
SCM IV Software Suite	SCM IV Software Suite: Version 1.2 or later SCM III Operations Software: Version 2.0 or later
Tape Measure	30 ft, 10 m, or longer
Volt Meter	Digital Voltage Meter

## 6 PROCEDURE

- 6.1 If placing an SCM Model IV Wearable Survey System into service, proceed to section 6.3
- 6.2 Cart Checkout
  - 6.2.1 For SCM Model IV proceed to Step 6.2.5
  - 6.2.2 Confirm circuit tester is operational and plugged into the Isobar.
  - 6.2.3 Computer and SCM Electronics are plugged into the enhanced side of Isobar and all other equipment is plugged into the basic side.
  - 6.2.4 Ensure all power cords are strain relieved near the Isobar.
  - 6.2.5 Inspect all cables and connectors for signs of wear or fatigue, and replace any suspect cables or connectors.
  - 6.2.6 Ensure all cables below the cart are run cleanly and strain relieved. No cable should be hanging.
  - 6.2.7 Confirm all connectors are in good working order; pins, grounding points, attachment mechanisms, etc are undamaged and properly interacting with opposite connector.
  - 6.2.8 Ensure all bolts are tight and have thread-locking compound (Loctight®).
  - 6.2.9 Ensure Front Lift Assembly operates cleanly when installed.
  - 6.2.10 Ensure two people can easily lift the SCM eight inches off the ground.
  - 6.2.11 Attach a PSPC with screen and wheels to the SCM; connect P-10 lines and MHV cables. Note: always ensure power to the MHV cables is off prior to connection or removal of MHV cables.
  - 6.2.12 Check entire gas system (including labeling and color coded tubing) for signs of wear or fatigue.
  - 6.2.13 Test drive the cart observing for constant speed and straight tracking.
  - 6.2.14 Ensure proper functioning of all switches on the Motor Control assembly.
- 6.3 Computer Checkout
  - 6.3.1 For SCM Model IV Proceed to Step 6.3.3
  - 6.3.2 SCM Model III
    - 6.3.2.1 Confirm DOS version 6.22 is installed on computer.
    - 6.3.2.2 Successfully run Scandisk and Defrag.
    - 6.3.2.3 Test all removable media drives (floppy and zip drive are required CD may be optional).

- 6.3.2.4 Confirm both the ADC and Counter cards have the correct addresses and settings and are properly installed. Pictures are in respective directories here:

Q:\Products\SCM\Hardware\Computers.

- 6.3.2.5 Confirm all fans are operating and are in good working condition.

- 6.3.2.6 Confirm whether the computer lock and key are needed for the survey.

- 6.3.2.7 Confirm all filters, fans, surfaces, etc are clean and dust free.

#### 6.3.3 SCM Model IV

- 6.3.3.1 Confirm latest version of Windows XP is installed on the computer.

**Note: The current system is not released for use with Windows Vista.**

- 6.3.3.2 Successfully run Scandisk and Defrag.

- 6.3.3.3 Back up and load a fresh copy of the SCM4 database.

- 6.3.3.4 Ensure the most recent release of the SCM4 software suite is installed and working.

#### 6.4 Electronics Checkout

- 6.4.1 Create a directory in the root directory of the computer called "CheckOut".

- 6.4.2 Ensure that the system is assembled in accordance with SCM-SETUP-02.

- 6.4.3 Purge a P-100 detector using SCM-OPS-01.

- 6.4.4 Run Voltage plateau in accordance with SCM-OPS-02 and select operating voltages on the alpha+beta and alpha plateau (as appropriate) unless directed by survey specific guidelines to select multiple plateaus.

**Note: The traditional operating point at sea level is typically 1925 volts for alpha+beta and 1250 volts for alpha.**

- 6.4.5 Perform position alignment using procedure SCM-OPS-03.

- 6.4.6 With SRAPA take a 10-minute count at the operating voltage(s) determined in step 6.4.4, and ensure that the response is flat and that there are no anomalies such as peaks in the position spectra.

- 6.4.7 Record the count rate in cpm (divide total counts by 10) for the full ROI under 10MinBkg Count Rate section of the table in Attachment A.

- 6.4.8 Save the spectra to the CheckOut directory using the file name 10MinBkg or similar file name.

- 6.4.9 Repeat steps 6.4.6 to 6.4.8 for each identified operating voltage.

- 6.4.10 Perform a linearity check.

- 6.4.10.1 Enter SRAPA
- 6.4.10.2 Place the left edge of the source 5 cm inboard from the left edge of the detector.
- 6.4.10.3 Take a 1-minute measurement.
- 6.4.10.4 Record the count rate in cpm for the full ROI under P5cmLS Count Rate section of the table in Attachment A.
- 6.4.10.5 Save the spectra to the CheckOut directory using the file name P5cmLS.
- 6.4.10.6 Place the source at the center of the detector.
- 6.4.10.7 Take a 1-minute measurement.
- 6.4.10.8 Record the count rate in cpm for the full ROI under PcentC Count Rate section of the table in Attachment A.
- 6.4.10.9 Save the spectra to the CheckOut directory using the file name PcentC.
- 6.4.10.10 Place the right edge of the source 5 cm inboard from the right edge of the detector.
- 6.4.10.11 Take a 1-minute measurement.
- 6.4.10.12 Record the count rate in cpm for the full ROI under P5cmRS Count Rate section of the table in Attachment A.
- 6.4.10.13 Save the spectra to the CheckOut directory using the file name P5cmRS.
- 6.4.11 Perform Daily SRC in accordance with SCM-OPS-06, and compare it to previous SRCs of the same configuration when available.

## 6.5 SCM Encoder Mode Field Tests

- 6.5.1 Perform a wheel encoder calibration in accordance with SCM-OPS-04.
- 6.5.2 Perform a PBC measurement in accordance with SCM-OPS-06.
- 6.5.3 Record data while running the SCM in encoder mode a minimum of 1 hour over the type of terrain expected to be encountered on survey operations.
- 6.5.4 During the test, change the survey name a minimum of 4 times.
- 6.5.5 Perform a PBC measurement in accordance with SCM-OPS-06 upon completion of steps 6.5.3 and 6.5.4.
- 6.5.6 Perform an Encoder Confirmation in accordance with SCM-OPS-04.
- 6.5.7 Give all recorded data to the anticipated Project Manager or a SIMS Level II trained personal for review.

## 6.6 SCM Static Mode Field Tests

- 6.6.1 Perform a PBC measurement in accordance with SCM-OPS-06.
- 6.6.2 Record data in static mode, using a four second count time for a minimum of 1 hour.
- 6.6.3 Throughout the test take strips in bursts and change the survey name periodically to simulate actual survey activity.
- 6.6.4 Record a minimum of 300 strips.
- 6.6.5 Perform a PBC measurement in accordance with SCM-OPS-06 upon completion of steps 6.6.2 and 6.6.4.
- 6.6.6 Give all recorded data to the anticipated Project Manager or a SIMS Level II trained personal for review.

## **7 REQUIRED RECORDS**

- 7.1 Attachment A – SCM CheckOut Form, or equivalent

## **8 ACCEPTANCE CRITERIA**

- 8.1 All collected data is approved by a Project Manager or SIMS Level II operator.
- 8.2 No anomalous behavior was observed and tests were performed without complication.

## **9 REFERENCES**

- 9.1 SCM-OPS-01, *PSPC Purging*
- 9.2 SCM-OPS-02, *PSPC Plateau Determination*
- 9.3 SCM-OPS-03, *PSPC Position Calibration*
- 9.4 SCM-OPS-04, *Encoder Calibration*
- 9.5 SCM-OPS-06, *PSPC Quality Assurance*
- 9.6 SCM-SETUP-02, *Hardware Setup*

# ATTACHMENT A

## SCM CHECKOUT FORM

<b>SCM S/N:</b>		<b>Radionuclide</b>			
<b>Detector Type:</b>		<b>Geometry</b>			
<b>High Voltage</b>		<b>Source S/N:</b>			
File Name	Location	Channels			Count Rate
		Centroid	FWHM	FW	cpm
P5cmLS	Left edge of source 5cm from left edge of the detector		to	to	
PcentC	Center of the detector		to	to	
P5cmRS	Right edge of source 5cm from Right edge of the detector		to	to	
10MinBkg	10 minute background				

Initials ____	SCM Motorized Cart moves at constant speed and does not pull to either side. Please mark as N/A for wearable system.	
Initials ____	Clean copy of current SCM Software and database if applicable loaded onto computer.	
Initials ____	10 minute background measurements showed no signs of anomalies.	
Initials ____	Passed	
Initials ____	Failed	Why: _____

Performed By: \_\_\_\_\_

Date: \_\_\_\_\_

Reviewed By: \_\_\_\_\_

Date: \_\_\_\_\_